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PROTOZOA:

CILIOPHORA.

BY

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AUTHOR'S PREFACE.

A SYSTEMATIC study of the microscopic forms of life is of comparatively recent data in India Freshwater, as well as parasitic, Protozoa have been studied by a number of workers in different parts of India, Burma, and Ceylon This volume deals with the Ciliophora, a group of animals which has always been a favourite study with microscopists on account of the complexity of their structure, the diversity of their habitats, and the interesting movements exhibited by them, and the same general plan adopted in other volumes of the series has been followed A systematic survey is likely to furnish a clear understanding of the group, and of the mutual relationships between the parasitic organisms and the free-living forms from which they must have been evolved, as remarked by Wenyon " the student of the Protozoa which are pathogenic to man and domestic animals should have a sound knowledge of other parasitic Protozoa, and at least a good working knowledge of non-parasitic forms as well. Conversely, those who study free-living Protozoa should have a clear conception of the parasitic forms ", and it is hoped that this volume will thus be of interest to medical and veterinary workers as well as to workers in general Protozoology

The most approved and up-to-date system of classification has been followed, and in the Identification Tables of Families I have included those families which are at present not known from India Those who use this volume should bear in mind that the 310 species here described are but a small fraction of the total known from other parts of the world

All species that are as yet known from India, Burma, and Ceylon have been brought together, but a large number still await discovery. The freshwater forms particularly are cosmopolitan, and future workers who discover forms different from those here described must not conclude that such forms represent new genera or species till they have carefully explored the vast literature on the subject, to which the Bibliography given at the end of the volume will furnish a guide.

The species of each genus have been arranged in alphabetical order, except where a number of groups of allied species have been recognized. In the synonymies, given under each species, references to all the records from India, Burma, and Ceylon have been included, and a † mark prefixed to all such references. A selection of other references, which are considered important or useful, is also given.

In the Introduction I have given lists of species found in different regions, and in the case of parasitic forms in particular hosts, in the hope that these may be of use to workers in particular areas and to those looking for the parasites in particular hosts. I have also included a short account of the principal methods employed in the study of the Ciliophora which may be of some use to those taking up the study of this interesting group.

A volume such as this is bound to incorporate very largely the work of others, and my grateful acknowledgements are due to all those whose works have been drawn upon. Where available, figures have been given for all species dealt with. A small number of these are original or taken from my own work, but a large number have been borrowed with the kind permission of the authors or publishers concerned. My special thanks are due to Prof. C. A. Kofoid and his colleagues, who have added so much to our knowledge of Indian Entodiniomorpha, for permission to reproduce certain figures and for the loan of the blocks of the plates that appear at the end of this volume. My thanks are also due to the editors

and publishers of journals and text-books from which illustrations have been reproduced with their kind permission, and for which due acknowledgement is made in every case by giving the name of the author from whom the figure has been copied, and also in several cases for the loan of blocks

My special thanks are due to Dr B Prashad, Director of the Zoological Survey of India, for special facilities given to me on the occasion of several visits to Calcutta to consult the literature in the splendid library maintained by the Zoological Survey, and also to Dr S L Hora for his help in getting some figures copied under his supervision by the artists working under him Finally, I have to offer my most grateful thanks to the Editor, Lieut-Colonel R B Seymour Sewell, C I E, F R S, for a thorough and critical revision of the text, and for generous help and guidance during the production of this work

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GLOSSARY OF TECHNICAL TERMS.

Aboral.—Situated furthest away from the mouth

Acetabuliform.—Having a cup- or sucker shaped outline

Adoral.—Conducting to the oral aperture

Afferent.—Conveying from the surface towards the centre

Amitotic division.—Direct division of the nucleus which is not accompanied by the formation of a spindle of threads

Anisogamy.—Copulation between dissimilar gametes

Anus, or *cytopyge*.—Opening or pore for defæcation of undigested remains of food

Basal granules.—Kinetic elements embedded in the contractile zone of the cortex, and each giving origin to a single cilium

Biconcave area.—A conspicuous biconcave area on each side of the body in the postero-dorsal region of certain Entodiniomorpha

Binary fission.—A mode of reproduction in which the division of the nucleus or of each of the two differentiated nuclei is followed by a division of the cell

Boundary layer.—Thin membrane separating the endoplasm from the ectoplasm It is well marked in Entodiniomorpha, and is continuous anteriorly with the wall of the gullet and posteriorly with the wall of the rectum

Brood chamber.—A cavity developed inside the body of a Suctorian within which ciliated embryos are produced

Buccal.—Relating to the mouth or oral aperture

Budding.—The process of unequal fission, resulting in the formation of daughter organisms, which show a simplified structure when first formed

Campanulate.—Having the shape of a bell

Carapace.—The indurated dorsal shield possessed by such ciliates as *Euplotes* and *Aspidisca*

Chitinous.—Corresponding in nature with chitin or the horny material which forms the protective covering of insects and other Arthropoda

Chlorophyll.—The green colouring-matter of vegetable organisms

Cilia.—The fine hair-like appendages that constitute the locomotive organs of a large group of Infusoria and many other animals

Ciliated embryos.—Buds provided with cilia which are developed in a brood chamber in a Suctorian, and finally emerge through a birth-pore

Cirri.—The elongate, flattened modifications of ordinary cilia, developed upon the peristomal region and other parts of the body of many ciliates.

Commensal.—An organism which does not live at the expense of the organism to which it is usually attached, but is associated with it simply as a messmate.

Concrement vacuole.—A vacuole which is interpreted as possessing a statolith function, found in certain types of parasitic ciliates.

Conjugation.—The temporary or permanent union of two organisms leading to reproduction by germs or spores or to the renewal of their capacity to multiply by simple fission.

Contractile vacuole.—One or more structures in the spongy layer of the ectoplasm which fill up by the excretory fluid draining into them and discharge the fluid on the surface of the body.

Convolute.—Rolled upon itself.

Cortical.—Relating to the external layer of an organism.

Crateriform.—Having the shape of a cup.

Crenulate.—Finely notched or serrated.

Cuirass.—An indurated defensive shield, synonymous with *Carapace*.

Cuticle.—The more indurated pellicle which forms the outer layer of the body of Infusoria.

Cyclosis.—The protoplasmic circulation observable in the cells of certain plants and also in many Protozoa.

Cyst.—Impervious membrane surrounding an organism, formed as a protection against desiccation in free living forms, or as an adaptation to a change of hosts in parasitic forms. In some cases cyst formation is related to the digestion of food, and in others to reproductive processes.

Cytomicrosomes.—Minute granules situated in the films between the alveoli in the ectoplasm as well as the endoplasm.

Cytopharynx.—Longer or shorter tube (popularly referred to as gullet) leading from the cytostome, and ending blindly in the endoplasm.

Cytoplasm.—The protoplasm of the cell-body as contrasted with that of the nucleus.

Cytopyge.—Anal aperture of unicellular animals.

Cytostome.—Oral aperture of unicellular animals.

Diastole.—Expansion of the contractile vacuole of Infusoria and other Protozoa.

Dichotomous.—Branching into pairs; furcate or forked.

Decurrent.—Running out or projecting beyond.

Dextrogyrous.—Circling towards the right.

Dextrotropous.—Turning to the right.

Dorsal disk.—A rounded ectoplasmic projection lying in the semicircle bounded by dorsal membranelles.

Dorsal membranelles.—The membranelles forming the dorsal zone.

Dorsal zone.—A zone of membranelles arranged in a transverse furrow on the dorsal surface of the body, found in certain Entodiniomorpha.

Ectoparasitic.—Having the nature of an external parasite.

Ectoplasm.—The denser external substance of Infusoria and other unicellular organisms.

Efferent —Conveying from the centre towards the periphery

Emarginate —Having a notched or excised margin

Encuirassed —Having an indurated dorsal shield or cuirass

Encystment —The phenomenon of becoming motionless and excreting a membranous investment or cyst, common to the majority of the Infusoria

Endogenous or *internal budding* —Formation of buds in the interior of the cytoplasm of the parent inside a brood-chamber

Endomixis —Periodic nuclear reorganization which occurs without conjugation or cell-fusion taking place

Endoparasitic —Having the nature of an internal parasite

Endoplasm —The inner, more fluid substance of the body of Infusoria and other unicellular organisms

Endoplasmic sack —The boundary layer with the enclosed endoplasm

Endoplast —The nucleus as developed in the Infusoria and other Protozoa

Endoplastule —The more solid particles developed singly or in varying number within or in many cases external to, the endoplast of Protozoa

Endoral —Referring to the fringe of cilia developed between the adoral and preoral series of certain Oxytrichidæ

Everted —The condition of being turned out or backwards

Excretory pore —A small permanent opening in the cuticle through which the contractile vacuole passes out its contents

Exogenous or *external budding* —Formation of buds from the external surface of the body

Fibrillæ —The delicate, thread-like structures developed in the cortical layer of many Infusoria, as also in the stalk of *Vorticella*, possessing a rudimentary muscular function

Fibrillar system —The whole complex of structures which serve a correlating and conductile function

Fimbriated —Fringed at the margin

Fission —Division of the nucleus or of both the differentiated nuclei followed by a division of the body

Food vacuole —A minute droplet of fluid in which a solid particle ingested as food is suspended and gradually digested

Funiculus —The slender, thread-like filament which connects the parts of the macronucleus in such infusorial types as *Loxodes* and *Loxophyllum*

Gamete —Sexual cell Among the Protozoa the entire individual, being a single cell, takes part in the process of conjugation

Gibbous —Unsymmetrically distended or swollen at some part of the surface

Glabrous —Having a smooth surface

Golgi apparatus —A cytoplasmic inclusion which shows a tendency to clump together in masses or to form a network in the neighbourhood of the nucleus

Holophytic —Organisms which feed in a plant like manner and, with the help of chlorophyll or similar pigment, in the presence of sunlight, build up simple organic substances from carbon dioxide and water

Holozoic.—Animals which are entirely dependent for food on other organisms which they capture, devour, and digest.

Illoricate.—Devoid of a protective sheath or lorica.

Indurated.—Having a hardened consistence.

Infundibuliform.—Funnel shaped.

Isogametes.—Gametes which are similar in shape and size.

Isogamy.—Copulation between similar gametes.

Karyogamy.—Sexual process or conjugation involving the union of micronuclear products.

Lævotropous.—Turning to the left.

Lorica.—The organically distinct protective sheath excreted and inhabited by many Infusoria such as *Vaginicola* and *Tintinnus*.

Loricate.—Possessing a protective sheath or lorica.

Macrochromatin.—In Protociliata, where the nuclei do not show dimorphism, each nucleus contains two types of chromatin, the macrochromatin being functional in vegetative life and the microchromatin during sexual phases.

Macrochromosomes.—Band shaped pieces into which the macrochromatin divides during mitosis of the nuclei in the Opalinids.

Macrogamete.—In those cases in which there is marked difference in size between two conjugating individuals, the larger is referred to as macrogamete.

Macronucleus or *meganucleus*. The larger of the two nuclei into which the nuclear apparatus is differentiated in Euciliata, which functions during the vegetative life of the organism.

Membranellæ.—The relatively large flattened cilia that constitute the peristomial fringe in many Ciliate Infusoria, synonymous with *Cirri*.

Membranelle rootlets.—Short fibrils extending posteriorly from the bases of the membranellæ.

Membranulæ.—Very long, delicate, finely pointed aggregates of cilia which differ from cirri in movement and in composition. They are, for example, found in *Didinium*.

Metabolic.—Changeable in form; polymorphic.

Metamorphic.—Changeable in form.

Microchromatin.—In Protociliata the nuclei do not show dimorphism, but each nucleus contains two types of chromatin, that which is functional in sexual phases being called microchromatin.

Microchromosomes.—Parts into which the microchromatin divides during mitosis of the nuclei in the Opalinids.

Microgamete.—The smaller of the two gametes in anisogamous conjugation.

Micronucleus.—The smaller of the two nuclei into which the nuclear apparatus is differentiated in Euciliata, which functions during the reproductive phases.

Microzooids.—Free swimming zooids of abnormally minute size which conjugate with the normal sized sedentary animalcules of many Vorticellidæ.

Mitochondria —Minute cytoplasmic inclusions of a lipoidal nature occurring in the form of spherical granules or rod-shaped or crescentic bodies

Mitotic —Indirect division of the nucleus which is accompanied by the formation of a spindle of threads

Moniliform —Jointed so as to resemble a string of beads

Morphonemes —Those fibres which maintain the body form

Motorium —A mass of differentiated protoplasm from which a number of fibres pass to different regions of contractile activity

Multinucleate —Possessing many nuclei, e g *Opalina*

Multiple fission A mode of reproduction in which the division of the nucleus or of the two differentiated nuclei is not immediately followed by the division of the cell but, after repeated nuclear division, the cell divides into as many parts as there are nuclei

Myonemes —Specialized muscle like fibrils which cause the contraction of the whole or a part of the body In a generalized condition they may be both coordinating and contractile in function

Myophan —Layer developed in many Infusoria, that contains muscle-like fibrils

Myophanes —Specialized fibrils which perform a contractile function only

Napiform —Turnip shaped

Neuromotor system —A system of connected fibrils emanating from the motorium and passing to different regions of contractile activity

Neuromotorium —A mass of differentiated material connected with the motor strand and other fibres performing conductile and contractile functions

Neurophanes —Specialized fibrils which perform a conducting function only

Nuclear dimorphism —The differentiation of the nuclear apparatus into a vegetative macronucleus and a reproductive micronucleus

Nucleolus —An exceedingly minute, more solid particle developed singly or in varying number within the substance of the nucleus of an animal or vegetable cell Its homologue among the Protozoa is generally referred to as *Endoplastule* or *Karysome*

Nucleus —More densely granular body within the substance of most animal and vegetable cells In Euciliata the nuclear apparatus is differentiated into a larger macronucleus and a smaller micro-nucleus

Œsophageal —Relating to or connected with the œsophagus

Œsophageal fibrils —Thin closely spaced fibrils forming the wall of the œsophagus and running parallel to its long axis

Œsophagus —A distinct tubular gullet or œsophageal tube leading from the cytostome to the endoplasm

Operculum —The lid-like structure developed within the sheath or lorica, or attached to the body of certain Vorticellidæ The term is also used for the ectoplasmic elevation separating the two membranelle zones in certain Entodiniomorpha

Oral —Relating to the mouth

Oral disk —The greatly thickened inner end of the adoral lip in Entodiniomorpha

Oral trichites —Armature of trichites or elongated rods of denser protoplasm embedded in the walls of the cytostome and the cytopharynx

Parasite —An organism living in or upon the body of another organism and dependent for its existence on that particular organism or a limited group of organisms

Paroral —The fringe of cilia developed at the side of the adoral series in certain Oxytrichidæ

Pectinate —Divided into narrow segments like the teeth of a comb

Pedicle —Lateral branches of the stalk in colonial Vorticellid form

Pedunculate —Provided with a stalk or peduncle

Pellicle, or periplast —The outermost layer of the cortex or ectoplasm, which is characterized by definite markings or sculpturings in many Ciliata

Peristome —The region, with its accompanying cilia, leading to the cytostome

Peristomial —Relating to the peristome

Pharyngeal —Pertaining to or connected with the cytopharynx

Pharyngeal basket, or *pharyngeal armature* —Trichites forming a tubular armature in the wall of the cytopharynx

Plicate —Disposed in pleats or folds

Polymorphic —Exhibiting a diversity of form

Preoral zone —The fringe of cilia developed in front of the mouth of certain Oxytrichidæ

Protoplasm —The physical basis of life, or elementary formative matter of all living organisms

Protozoa —Animals in which the body is not divided into cells

Racemose —Having a clustered form of growth, like a bunch of grapes.

Rectum —A thin walled tube arising ventrally from the endoplasmic sack, extending posteriorly through the ectoplasm and opening to the exterior by the anus

Reniform —Shaped like a kidney

Revolute —Rolled back upon itself

Rhizoplasts —Fine endoplasmic prolongations from the basal bodies of membranulæ to the vicinity of the nucleus

Rhythmical —Denoting the regular pulsations of an organ such as the contractile vacuole of a Ciliate

Rod apparatus —An armature of elongated rods or trichites embedded in the walls of the cytostome and the cytopharynx

Saprozoic —Organisms living upon organic substances in solution, which are products of the metabolism or decay of other organisms

Setæ —The stouter bristle like cilia possessed more abundantly by the Hypotricha

Sigmoidal —Having a shape resembling the letter S

Siliceous —Partaking of the nature and qualities of silica, composed of flint

Silver line system —Collection of certain structures on which colloidal silver is deposited by the reduction of silver nitrate by reflected sunlight

Skeletal plates.—Hard, chitinous structures lying beneath the cuticle and extending backwards from the oral area in certain genera in the family Ophryoscolecidæ.

"*Soie de Lachmann*."—Oral seta of the Vorticellidæ, also known as the *Vestibular seta*.

Spasmoneme.—The excentrically placed myoneme running through the stalk of a Vorticellid, which is surrounded by a granular thecoplasm and a delicate outer sheath.

Spatulate.—Having a broad blade-shaped outline.

Spine.—A pointed tapering process.

Sporulation or *multiple fission*.—Mode of reproduction in which the repeated division of the nucleus is followed by the splitting of the organism into as many parts as the nuclei.

Stolon.—The procumbent adherent basal region of the colony-stock of such a type as *Dendrosoma*.

Suctorial tentacles.—Stiff protoplasmic processes consisting of a parietal layer of ectoplasm in the form of a tube enclosing a canal containing a fluid, the apex of the tentacle usually terminating in a sucker-like knob.

Syngamy.—Sexual union or conjugation involving either a complete fusion of two organisms (gametes) or the temporary fusion of two organisms (conjugants) for the purpose of mutual exchange of micronuclear material.

Synkaryon.—The combination nucleus which results from the fusion of two micronuclear products derived from two individuals.

Systole.—Contraction of the contractile vacuoles.

Tentaculiferous.—Bearing or possessing tentacles.

Tentaculiform.—Having the form of a tentacle.

Thecoplasm.—The granular, fluid substance which surrounds the spasmoneme in the stalk of a Vorticellid.

Thecoplasmic granules.—Small granules contained in the thecoplasm alongside the spasmoneme, the number and arrangement of which vary in different species.

Trichites.—Stiff rod-like supporting structures usually found in the oral region.

Trichocysts.—Minute rod like bodies developed in the cortical layer of many Ciliata, and composed of a sac within which is a long coiled-up thread that can be suddenly extruded.

Uncini.—The claw-like modification of ordinary cilia possessed by many Hypotricha.

Undulating membrane.—Aggregates of cilia formed by the fusion of one or more rows of cilia, ranging from delicate structures to large balloon-like expansions, usually found in the peristomial area inside the adoral zone.

Vacuolate.—Having a number of clear spaces or vacuoles.

Velum.—Delicate veil like membrane bordering the oral orifice in such forms as *Cyclidium* and *Pleuronema*.

Vermicular.—Resembling a worm in shape.

Vestibular seta.—The bristle like cilium or seta that projects from the vestibulum or oral fossa of many Vorticellidæ.

Vestibule.—The excavated chamber or fossa into which both the oral and anal apertures debouch, as developed in the Vorticellidæ.

Zoodendrium.—Dendritic or tree like colony stocks of such ciliates as *Dendromonas* and *Epistylis*.

Zooid.—An animal organism not independently developed from a fertilized egg or ovum, but derived from a preceding individual by the process of fission or gemmation. Specially applicable to the Ciliophora and other Protozoa, and to the component members of all colony-building communities, such as Polypes, Corals, and Polyzoa.

Zygote.—The cell resulting from the complete fusion of two gametes.

SYMBOLS

† prefixed to a reference indicates that the record of certain species from India, Burma or Ceylon is based on this work.

* placed after the name of a family indicates that representatives of that family have not yet been found in India, Burma or Ceylon.

SYSTEMATIC INDEX.

CILIOPHORA.

INTRODUCTION

Position of Ciliophora in the Animal Kingdom.

PROTOZOA are generally defined as unicellular animals All the functions of animal life are performed by a small undivided mass of protoplasm The body of the organism, unlike the body of a higher animal, is not differentiated into organs consisting of tissues or cell-aggregates set apart for the performance of different functions Although a Protozoon, when seen under a microscope, is comparable in its structure with a single cell of a Metazoan body, it cannot be regarded as strictly homologous with it Some authors consequently prefer to regard PROTOZOA as non-cellular—that is, representing a primitive type of body in which the cellular type of structure had not been evolved Although many of these organisms present a fairly simple structure, the majority of them exhibit a complexity of structure to which there is no parallel among the cells forming the body of a higher animal The reason is obvious The various parts of the cell-body of a Protozoon are differentiated into structures for the performance of different functions of animal life, such as locomotion, food capture, sensation, reproduction, etc , but all this is within the limits of a single mass of protoplasm Hence the organization of the PROTOZOA is actually by no means simple It is not the object of this work to give a comprehensive account of the organization and structure of the PROTOZOA for this the reader should refer to the numerous excellent text-books on the subject

The PROTOZOA are microscopic organisms, and have been favourite objects of study under the microscope ever since the latter was invented Leeuwenhoek, the father of Protozoology, first described (1677) a free-living Protozoan, a species of *Vorticella*, which he had seen in standing rain-water in 1675 He was also the first to publish an account of a parasitic Protozoan (1682), which he found in his own fæces, and which was the flagellate *Lamblia* (*Giardia*) *intestinalis* In 1683 he found *Opalina* in the fæces of a frog, and possibly *Nyctotherus*

also In 1703 he figured both *Vorticella* and *Carchesium* *Paramecium* was discovered in 1703 and *Amœba* in 1755 Ledermuller, in 1763, was the first to introduce the popular term INFUSORIA, to include all the various microscopic animalcules which make their appearance in infusions exposed to the air The first comprehensive work on INFUSORIA was the monograph by O F Muller, published posthumously in 1786, and "included, besides the Protozoa, Bacteria, Diatoms, Vinegar Worms, Planarian worms, Cercaria larvæ, Rotifers and other odds and ends of animals, provided that they were sufficiently small" Muller described 378 species in his monograph, of which about 150 are valid The term PROTOZOA was first used by Goldfuss in 1817, but he included in the group the POLYPES and MEDUSÆ also It was first restricted and employed in the modern sense by von Siebold in 1845 Ehrenberg published a large work in 1838 in which 350 species are described from his own observations About one-third of this work was devoted to Rotifers Dujardin (1841) was the first to divide the "Infusoires" into rhizopods, flagellates, and ciliates, according as pseudopodia, flagella, or cilia serve as their organs of locomotion This division is still the basis of all the schemes of classification of the PROTOZOA Butschli (1889) limited the use of INFUSORIA to PROTOZOA that bear cilia at some period of their life history As these latter came to be regarded as constituting two classes, viz, the CILIATA, with cilia throughout life, and SUCTORIA, with cilia in the embryonic phases only, Doflein (1901) introduced the term CILIOPHORA to designate a sub phyllum to include these two classes

Besides the classes enumerated above, there is the class SPOROZOA, including organisms which are exclusively parasitic and which possess no special organs of locomotion and food capture The earliest observations on a Coccidian and a Gregarine were published in 1839 The HÆMOSPORIDIA were discovered as late as the eighties of the last century

The phylum PROTOZOA may thus be divided as follows —

A Subphylum PLASMODROMA Doflein, 1901
Movement is effected by pseudopodia or flagella, and syngamy takes place in all known cases by the complete fusion of gametes

I Class MASTIGOPHORA Diesing, 1865
The predominating phase is flagellate, locomotion being effected by filamentous whip like structures called flagella The body may be corticate or non corticate

II Class RHIZOPODA von Siebold, 1845 (=SARCODINA Hertwig & Lesser, 1874)
The predominating phase is amœboid, locomotion being effected by temporary extensions of the body called pseudopodia The body is non corticate, *i e*, has no tough limiting mem brane or cuticle

III Class SPOROZOA Leuckart, 1879
Exclusively parasitic forms which lack definite organs of locomotion Reproduction takes place by spore-formation

B Subphylum CILIOPHORA Doflein, 1901
Movement is effected by cilia

IV Class CILIATA Perty, 1852
Organisms bear cilia throughout life

I Subclass PROTOCILIATA Metcalf, 1918
Organisms provided with two or more nuclei, which are all of one type Syngamy is effected by the complete fusion of uninucleated stages

II Subclass EUCILIATA Metcalf, 1918
Organisms show a definite nuclear dimorphism, there being two types of nuclei (macronuclei and micronuclei) During syngamy the macronuclei disintegrate, the micronuclei divide, and an interchange of micronuclear products takes place between the associating individuals, new macronuclei and micronuclei being reconstituted from the combination nucleus or synkaryon

V Class SUCTORIA Claparède & Lachmann, 1858 (=TENTACULIFERA Huxley, ACINETARIA Lankester)
Ciliated in the young stages, but later usually attach themselves to other objects, lose their cilia, and develop knobbed tentacles which serve as sucking-tubes

General Organization and Structure.

The present volume deals only with the subphylum CILIOPHORA, and I give below a brief survey of the general organization and structure of the organisms included in this group, so as to afford the reader a general idea of the group and to introduce him to the principal technical terms employed in the description of the forms

Modes of Life —The great majority of CILIOPHORA are free-living aquatic forms, either marine or freshwater Some groups of the CILIATA and practically all SUCTORIA are attached They may be attached temporarily or permanently to some object, which may be the body of some other animal A considerable number of forms are parasitic and show various degrees of dependence on the host

Form —The free-swimming Ciliates show a great variety of forms The primitive type may be considered to be a spherical or ovoid organism, with the mouth or cytostome at the anterior end and the contractile vacuole near the posterior end Cilia of equal length clothe the whole body evenly, being disposed in meridional rows extending from the anterior to the posterior pole Such an ideally simple type is actually met with among species of *Holophrya* and *Prorodon* (see figs 22, 25) Modifications from this type occur as the result of (1) shifting of the cytostome from the anterior pole to one side of the body and a consequent oblique arrangement of the ciliary

rows, (2) differentiation of the cilia into those covering the general surface of the body, which are locomotor in function, and special cilia near or around the mouth, which are variously modified for the purpose of food capture, (3) development of a special area, called peristome, leading to the cytostome, (4) the flattening of the body in creeping forms, in which a ventral surface, bearing cytostome and peristome, is distinguishable from the dorsal surface, and (5) restriction of the locomotor cilia to the ventral surface, and the complete or partial disappearance of those on the dorsal surface or their retention to serve a purely tactile function This last and extreme modification is realized in such flattened and creeping hypotrichous forms as *Stylonichia* and *Aspidisca* (figs 180, 184), in which the ventral cilia are restricted to tufts which fuse to form cirri or bristles on which the animal creeps

Organisms may be temporarily or permanently attached For this purpose there are developed special cilia or adhesive organs, or the surface of the body on the side opposite to the mouth (aboral) may be specially drawn out for the purpose into a stalk In *Vorticella* and other related organisms the stalk contains a contractile thread, by means of which the organism can retract itself close to the point of attachment or extend itself further away from it In this group the general covering of cilia disappears and only peristomial cilia are retained Such organisms may, however, detach themselves from their stalks, develop temporary cilia for locomotion, swim off, and attach themselves again elsewhere

Structure —The protoplasm forming the body of a Ciliate is differentiated into two layers, ectoplasm and endoplasm The *ectoplasm* consists of four or five layers, viz (a) a thin delicate membrane called the *pellicle*, (b) *alveolar layer*, (c) protoplasmic layer containing small spindle-shaped bodies known as the *trichocysts*, (d) *contractile layer*, containing *myonemes* which run beneath and parallel to the ciliary rows at the surface, and (e) *spongy layer*, traversed by irregular spaces and channels containing fluid which drains into more conspicuous feeder-canals which open into a *contractile vacuole* These layers or zones cannot be clearly distinguished in all cases as they grade into one another, and some of them are better developed in some organisms than in others The *cytostome* or mouth, the *cytopyge* or anal aperture and the openings of the contractile vacuoles all perforate the pellicle, and the cilia also pass through it

The *cilia* arise from basal granules placed externally to or between the myonemes, and pass to the exterior through the outer layers The cilia may be restricted to certain regions (as in *Didinium nasutum*, *Urocentrum turbo*, etc, figs 31, 89), or may by their fusion form locomotor organs

of a complex nature, such as *undulating membranes, membranelles, cirri and membranulæ* Undulating membranes are usually formed by the adhesion or fusion of a single row of cilia, and may occur in the cytopharynx, margin of the cytostome, or in the peristome, they are represented in all orders of the CILIATA They are usually narrow and inconspicuous, but in some genera (e g, *Cyclidium*, *Pleuronema*, figs 85, 86) form large balloon-like expansions used for trapping the food Membranelles are formed by the fusion of the cilia in the region of the mouth They are grouped as a rule in a curved row, the "adoral zone," along the margin of the peristome in all orders of the CILIATA except the HOLOTRICHA (fig 117) A dorsal ring of membranelles is also present in some parasitic forms, e g, *Diplodinium* (fig 158) In the Vorticellidæ (fig 187) there are two rows of membranelles, forming a double adoral zone that winds about the peristome in a direction opposite to that in SPIROTRICHA (which includes HETEROTRICHA, HYPOTRICHA, etc) Cirri are formed by the fusion of tufts of cilia, and are broader at the base and taper to a fine point They are found typically on the ventral surface of HYPOTRICHA, and form groups named, according to their position, frontal, ventral, anal, caudal and marginal cirri These cirri confer extreme variety of movements on the HYPOTRICHA Some of them run on the tips of the frontal and ventral cirri (*Stylonichia*), others swim with a jerky movement (*Aspidisca*), while yet others combine swimming by means of the adoral zone of membranelles with sudden jumps effected by anal or caudal cirri (*Euplotes*). In a few cases dorsal cirri also occur and serve a tactile function (*Uronychia*) Membranulæ are long, delicate, finely pointed structures, each formed by the fusion of a small number of cilia, as in the case of the two circlets of *Didinium* or the posterior ciliary ring of Vorticellids

A striking feature of many Ciliates is their power of contraction A *Spirostomum* or a *Trachelocerca* will suddenly contract to a fraction of its length in the expanded state A *Folliculina* or a *Vorticella* will fold itself up, and an entire colony of Vorticellids may contract itself into a small mass These movements are brought about by long, delicate, contractile threads, called *myonemes*, which may run straight (*Stentor*) or spirally (*Spirostomum*) throughout the entire length of the body A second set of myonemes may run transversely about the body, as in the peristomial region of the Vorticellids or *Stentor*

In Ciliates with a uniform covering of cilia the latter do not all beat simultaneously, but a wave of contraction passes from the anterior to the posterior end Cilia in the same transverse row beat synchronously, but those in a longitudinal

row beat in a regular succession and are metachronous in their contraction This also accounts for the wave-like movement of undulating membranes which are formed by the fusion of longitudinal rows of cilia Distinct fibres connecting the basal granules of cilia were described by Entz, Maier, Schuberg and others, but were interpreted as myonemes As, however, the rhythmic action of the cilia is independent of the contractility of the organism, it is probable that such fibres are not myonemes but co-ordinating fibres of a conductile nature Sharp, Yocom, and Taylor have given convincing evidence of the occurrence of specific conducting or co-ordinating system of fibrils Sharp (1914) was the first to describe in *Epidinium ecaudatum* (fig 164) a *neuromotor system* of fibrils connecting the basal fibrils coming from the cilia or groups of cilia with a co-ordinating centre called the *motorium* The motorium is situated in the ectoplasm near the anterior end of the organism, and a number of fibres pass to different regions of activity Yocom (1918) described a similar but more complex system in *Euplotes patella* A definitely staining bilobed mass situated in the ectoplasm near the right anterior angle of the triangular peristome was identified as a motorium (fig 183, *m*) From one of its lobes a set of five longitudinal fibrils (*a–c*) run to the bases of the five anal cirri near the posterior end, and from the other lobe a single fibril passes along the inner margin of the anterior lip and down the left side of the peristome connecting the bases of the adoral zone of membranelles (*m f*) Taylor (1920), as the result of micro-dissection experiments with the same form, furnished direct evidence of the part played by the neuromotor apparatus Macdonald (1922) described a similar system in *Balantidium coli* and *B suis*, and since that date several other workers have demonstrated the neuromotor apparatus in other forms

Klein (1926) introduced a modification of a silver impregnation method, by which the organisms are fixed by drying, and the reduction of silver nitrate by reflected sunlight deposits colloidal silver on certain structures, which are referred to collectively as the "silver-line system" This system is composed of two rather distinct parts One of these, described as "indirectly connected" with the contractile system, is composed largely of closely set polygons and the trichocyst granules which lie in the centres of the anterior and posterior sides of the polygons The other portion consists chiefly of the basal granules, which are located at or near the centres of the polygons of the first part, and the longitudinal body fibrils, which connect the basal granules in the same longitudinal row of polygons Lund (1933) has correlated the "silver-line" system with the "neuromotor" system, and comes to the

conclusion that the "silver-line" system is not solely composed of conductile elements, but comprises parts of at least two, and possibly three, quite different aggregations of structures, namely, the pellicle, the trichocysts, and the peripheral portion of the neuromotor system. Klein's technique fails to demonstrate the great pharyngeal complex, which is at least in part conductile. The term "fibrillar system" may be employed to include the whole complex of structures which serve a correlating and conductile function.

Embedded in the ectoplasm are small spindle-shaped bodies known as *trichocysts*, each of which on being stimulated can discharge a long stiff thread. They may be distributed all over the surface (*Paramecium*, fig. 63) or be confined to certain regions (proboscis of *Dileptus*, fig. 45). Oral *trichites* are similar structures surrounding the mouth in various GYMNOSTOMATA, and may form a tube extending into the endoplasm (as in some species of *Nassula*, *Orthodon* etc.). In other cases much larger rods are met with, and form *pharyngeal baskets* (as in the families Nassulidæ and Chlamydodontidæ). A constant number of rods may be found in a species, and they may be united to form a tube at the posterior end of the basket (fig. 56).

The number and arrangement of the contractile vacuoles varies considerably. In *Paramecium* there are two contractile vacuoles, each surrounded by six to eight feeder-canals in a star-like manner. In *Stentor* and *Spirostomum* there is a single contractile vacuole, with a long feeder-canal running along the length of the body.

A mouth or cytostome is normally present (except in PROTOCILIATA, ASTOMATA and SUCTORIA). In GYMNOSTOMATA the cytostome is closed except during the ingestion of solid food; it is opened or closed by a system of rods contained in the cytopharynx, and there is no undulating membrane. In all other CILIATA which possess a cytostome it is permanently open, and the cytopharynx may possess one or more undulating membranes, but no rod-apparatus. Frequently there is a funnel-like structure called the *peristome* for collecting the food and conveying it to the cytostome. Cilia on the floor of the peristome are often longer than over the rest of the body. In SPIROTRICHA an adoral zone of membranelles is always present along the left margin of the peristome. In the PERITRICHA the adoral zone consists of two parallel undulating membranes, which, after describing a number of spiral turns, pass into a funnel-shaped depression or vestibule, at the bottom of which the cytostome, followed by a short cytopharynx, is situated. The contractile vacuole and the anus also open into the vestibule. In SUCTORIA there is no cytostome, but food is taken in by the numerous sucking

tentacles, the protoplasm of the body of the prey passing in a stream through the tubular cavity of the tentacle The majority of CILIOPHORA are holozoic, but some of the parasitic forms may be saprozoic (*Opalina*)

The endoplasm is finely alveolar and more fluid than the ectoplasm, and exhibits a streaming movement (*cyclosis*) The endoplasm contains food-vacuoles enclosing food-particles in process of digestion, the nuclei, and other refringent granules, some of which may be excretory granules, others mitochondria and still others belonging to the Golgi apparatus

The nuclear apparatus in most CILIOPHORA shows dimorphism —there being a large, deeply staining macronucleus and a small, often inconspicuous, micronucleus which is difficult to stain In PROTOCILIATA there are two or more similar nuclei, but in each nucleus there are believed to be two kinds of chromatin, distinguished as macrochromatin and microchromatin The former is functional during vegetative life and the latter during the reproductive phases Among the EUCILIATA the macronucleus is typically a compact body, and the micronucleus a small refringent body close to it or actually lodged in a depression of the surface of the macronucleus In other forms the macronucleus may be rod-shaped or sausage-shaped (*Diplodinium*), or in the form of a horseshoe (*Vorticella*) or a beaded string (*Stentor* and *Spirostomum*), or there may be two macronuclei connected by a delicate filament (*Stylonichia*), or the macronucleus may be broken up into a large number of small nuclei The macronucleus in some of the SUCTORIA (*Dendrosoma*, *Ephelota*, etc) is much branched The micronucleus does not vary much in form, but the number of micronuclei may be one, two, or many in different species

Reproduction —Macronuclei are vegetative in function and control the general metabolism during reproduction they disappear by absorption and fresh macronuclei arise from products of micronuclear division The micronucleus is reproductive in function and plays an important part during conjugation, as also in periodical reorganization without conjugation, known as endomixis

Reproduction takes place by binary fission which is generally transverse to the long axis of the body During this process the macronucleus divides amitotically and the micronucleus mitotically The nuclear division is followed by transverse fission of the organism, and the parts lacking in each daughter organism are reconstituted In fixed forms, as in Vorticellidæ, the fission is generally in a vertical plane and leads to unequal fission or budding Repeated fission accompanied by imperfect separation of daughter zooids leads to the formation of large branching colonies in many PERITRICHA Multiple

fission or sporulation also occurs inside temporary cysts in some parasitic forms In SUCTORIA either external or internal budding takes place In internal budding a certain part of the organism becomes invaginated, the margins close over, and a brood-chamber is formed, inside which the ciliated embryos are developed

The details of conjugation or syngamy also vary a good deal in the group Among the PROTOCILIATA ordinary individuals divide repeatedly, and thus give rise to a number of small-sized forms with one, two or more nuclei, these then encyst and pass out with the fæces of the host These cysts are ingested by tadpoles and the organisms are set free in their rectum The organisms multiply and give rise to larger and smaller individuals (gametes) which fuse in pairs to form a zygote Each resulting zygote has at first a single nucleus, and later gives rise to the binucleated or multinucleated condition characteristic of the species In most of the EUCILIATA temporary fusion takes place between similar zooids, the macronucleus degenerates and disappears in each conjugant, and the micronucleus in each divides two or three times Only one of the resulting products of micronuclear division takes further part in the process, the others being absorbed This remaining micronucleus again divides into two pronuclei, one migratory and the other stationary The migratory pronucleus of each passes into the body of the other conjugant and fuses with its stationary pronucleus, forming a synkaryon in each The conjugants now separate, the synkaryon in each divides a number of times, resulting in the formation of new macronuclei and micronuclei, and each ex-conjugant divides into a number of zooids, each zooid containing a single macronucleus and one or more micronuclei according to the species In the majority of the PERITRICHA sexual dimorphism is the rule, and a small zooid fuses permanently with a large zooid, and only a single zygote with one synkaryon results

A periodic nuclear reorganization also takes place apart from conjugation, and was described by Erdmann and Woodruff (1914) in *Paramecium aurelia* and by the same authors (1917) in *P caudatum* under the name endomixis In the former species it takes place at intervals of about thirty days, the old macronucleus breaks up and is absorbed, and each of the two micronuclei divides twice, forming eight products, some of which become new macronuclei and some new micronuclei In the latter it occurs at intervals of sixty days; the single micronucleus divides three times, forming eight nuclei, some of which degenerate while others form new macronuclei or micronuclei In some other types of Ciliates endomixis is known to take place while the organism is protected by a cyst

Study of the Group in India.

Very little work had been done on the Ciliate PROTOZOA in India during the last century Up to the year 1889, the year of publication of Butschli's great work on PROTOZOA, practically the only record of freshwater forms was the work of H J Carter, who studied these forms in Bombay towards the middle of the last century, and contributed a number of papers on the organization of freshwater INFUSORIA of the island of Bombay to the 'Annals & Magazine of Natural History' (1856–69) The following is a list of Ciliates found by him in Bombay, a number of forms, described as new species by Saville Kent (1880–82) from manuscript notes that Carter placed at his disposal have also been included in the list —

Holophrya lateralis S K
Coleps hirtus (O F Mull)
Halteria pulex=*Mesodinium pulex* Cl & L
Trachelium fasciola=*Amphileptus fasciola*=*Lionotus fasciola* Ehrbg
Nassula sp
Loxodes cucullulus=*Chilodon cucullulus* Ehrbg (O F Mull)
Ophryoglena sp =*Otostoma carteri* S K
Loxodes cucullio=? *Colpoda cucullus* (O F Mull)
Paramæcium aurelia Ehrbg (O F Mull)
Plagiopyla (?) *carteri* S K
Spirostoma virens (?) Ehrbg =*Climacostomum virens* Ehrbg
Bursaria leucas (?) Ehrbg =*Frontonia leucas* Ehrbg
Stentor sp
Oxytricha sp
Himantophorus charon=*Plœsoconia* ?=*Euplotes charon* O F Mull
Euplotes sp
Vorticella microstoma Ehrbg
,, *convallaria* Ehrbg
,, sp
Epistylis galea (?) Ehrbg
Cothurnia sp =*Pyxicola carteri* S K
Sphærophrya sp Cl & L
Podophrya fixa Ehrbg
,, *quadripartita*=*Tokophrya quadripartita* Cl & L
Acineta tuberosa Ehrbg

G W Grant had previously (1842) found in Calcutta six species of freshwater PROTOZOA, of which only two were Ciliates, viz, *Coleps hirtus* Ehrbg and *Vorticella patellina* O F Mull These are recorded in Cantor's work on Chinese forms In 1862 J Mitchell contributed a short note on the existence of a valve in a form very similar to *Vaginicola crystallina* from Bangalore W J Simmons (1889) contributed a note on a species of *Podophrya* found in Calcutta, and (1891) noted the occurrence of several genera at Calcutta without specific identification of the forms H H Anderson (1889) described *Anoplophrya ælosomata* from *Ælosoma chlorostictum* in Calcutta

Scanty as the above recorded work is for a large country like India, it is thus referred to in Schewiakoff's monograph on the geographical distribution of freshwater PROTOZOA (1893, p 84) "Bedeutend besser erforscht ist die Protozoenfauna Ostindiens, obgleich die vorliegenden Befunde weit davon entfernt sind, eine methodische Durchforschung der Susswasser Protozoen diese landes darzubieten Es wurden nur wenige Orte, Bombay, Calcutta und einige Seen in Himalaya, von Carter, Grant und Simmon untersucht Am eingehendsten erforscht Carter die sussen Gewasser von Bombay und fand daselbst 43 verschiedene Formen, darunter 12 Rhizopoden, 3 Heliozoen, 15 Mastigophoren, 10* Ciliaten und 3* Acineten, die sammtlich auch in Europa anzutreffen sind Nur wenige von diesen Formen lassen sich nicht ermitteln In den Seen vom Himalaya fand Carter zwei Dinoflagellaten, darunter eine angeblich neue Art, die aber mit einer europaischen zu identificiren ware Bei Calcutta fand G W Grant 6, gleichfalls in Europa vorkommende, Protozoen welche in der Arbeit Cantor's beschrieben werden Endlich traf bei Calcutta noch Simmons eine Acineten an, uber die ich aber nichts zu sagen vermag, da ich mir leider die betreffende Arbeit nicht verschaffen Konnte Somit wurden in Ostindien 50 verschiedene Arten von Protozoen 12 Rhizopoden, 3 Heliozoen, 19 Mastigophoren, 13* Ciliaten, 3* Suctorien (Acineten) beobachtet, die alle Europaer sind"

From 1891 to 1916 very few persons took up the study of this group in India Eugen von Daday (1898) studied the freshwater PROTOZOA of Ceylon, and, in addition to a large number of Rhizopods and Flagellates, also recorded six Ciliates, viz, *Colopoda cucullus* (O F Mull), *Codonella lacustris* Entz , *Tintinnopsis ovalis* Dad , *Oxytricha mystacea* St , *Stylonichia pustulata* (O F Mull), and *Epistylis anastatica* Ehrbg Annandale (1907) recorded *Carchesium polypinum* Ehrbg and *Folliculina ampulla* (O F Mull) in his work on the Fauna of Brackish Ponds at Port Canning, Lower Bengal Dobell (1910) published a paper on some parasitic PROTOZOA from Ceylon, in which he described the following new species of Ciliates —*Balantidium ovale*, *B hyalinum*, *Nyctotherus papillatus*, *N termitis*, and *Opalina virgula*

In 1916 I published some notes on the Ciliate PROTOZOA of Lahore, and followed this up by further papers in 1920, 1922, and 1923 Gulati (1925) published his observations on some more Ciliates from Lahore Bhatia and Gulati (1927) studied some parasitic Ciliates from a number of frogs, toads, earthworms, and the common cockroach found in the

* This enumeration is not correct, as forms erected into new species by Saville Kent from manuscript notes of Carter are not included

Punjab , and Bhatia and Mullick (1930) studied the freshwater Ciliates of Kashmir

During the same period (1916–29) Ekendranath Ghosh worked on the Ciliates at Calcutta, and published no less than fifteen papers recording known and describing many new species Most of these papers are, however, of the nature of short communications, and his descriptions are not always adequate and reliable Essential points are very often left undetermined, and future workers will not find it easy to recognize the organisms from his description and figures Similarly, H S Madhava Rao published (1928) a paper on Soil PROTOZOA from Mysore, in which he has shown carelessness of observation and even ignorance of the ordinary rules of zoological nomenclature and description Sandon (1927) and Chaudhuri (1929) have added a large number of forms to the records from India by examining the soils from various parts of India Kofoid and MacLennan (1930–33) have described a large number of parasitic Ciliates from *Bos indicus*, the material having been obtained in South India and Ceylon De Mello (1930–34) has published a number of papers on the parasitic Ciliates from various frogs and toads from Nova Goa (Portuguese India) Kofoid and Christenson (1934) have described a large number of Ciliates from *Bos gaurus* from Mysore, and Kofoid (1935) two remarkable Ciliates from the elephant Lastly, Das Gupta (1935) has described many Ciliates from *Capra hircus* at Calcutta

In the present work all the records from India are brought together The record comprises 310 species, belonging to no less than 104 genera, out of which the specific identity of as many as 39 is uncertain Of these, 68 species belonging to 41 genera, of which 1 genus and 16 species are new to science, have come under my personal observation For the description of previously known genera and species I have consulted, among others, the monographs of O F Muller, Ehrenberg, Dujardin, Claparède and Lachmann, Stein, Engelmann, Fromentel, Saville Kent, Butschli, Schewiakoff, Roux, Penard, Metcalf and Kahl I have in the main followed the classification given in Doflein and Reichenow's 'Lehrbuch' (1929) and in Kahl's recent monograph on INFUSORIA in 'Tierwelt Deutschland' (1930–35) All the families, even when not so far known to be represented in India, have been mentioned, and tables of identification included Although the ciliate Protozoan fauna of India is now much better known than it was twenty years ago, there are many genera and even families that are not yet represented As the freshwater forms are known to be cosmopolitan in their distribution, there is every likelihood of their being found in India as the result of further research

Classification and Phylogeny.

The basis of the present-day systems of classification of the CILIOPHORA was first suggested by Stein in 1857, and with various modifications, introduced by Saville Kent, Butschli, Schewiakoff, Delage, Doflein, Metcalf, Reichenow and Kahl, is followed even to-day. Stein divided the CILIATA into four orders, viz., HOLOTRICHA, HETEROTRICHA, HYPOTRICHA, PERITRICHA, and to-day these are still recognized as orders or suborders. For many years Stein held the opinion that the organisms, since recognized as constituting the group TENTACULIFERA, represented merely the developmental phases of various Vorticellids. The researches of Claparède and Lachmann won for them an independent position, possessing, as a distinct section of the INFUSORIA, the same status as FLAGELLATA and CILIATA, and, with reference to the possession of sucking tentacles, the title of SUCTORIA was conferred by them on the group. Later Huxley, in view of the fact that in certain forms a portion only of the tentacles are suctorial, and that in some others the tentacles may be entirely non-suctorial and simply prehensile, substituted the title of TENTACULIFERA for the SUCTORIA. At a still later date the name ACINETARIA was given to them by Lankester. The similarities of the early stages of these organisms to the CILIATA were well understood, and Doflein recognized that CILIATA and SUCTORIA constituted two classes of the subphylum CILIOPHORA.

The class CILIATA continued to be described as consisting of four orders, as defined by Stein. The order HOLOTRICHA includes those Ciliates in which the cilia are all of approximately equal length and thickness, and there are never any specialized structures called cirri. It thus included the simplest members of the class, but still presented a considerable range of complexity from the simplest forms to those nearly approaching the HETEROTRICHA. *Opalina* and other astomatous forms were included in the order as primitive forms or as forms which were without a mouth on account of their parasitic mode of life. Excluding these, Stein divided the order into four families. Saville Kent considered these groups or families as more or less heterogeneous, and distributed the genera among twelve families. Later authorities have had to transfer many of the genera and even families to other orders or even other classes of PROTOZOA. Butschli divided the order into two sub-orders:—(1) the GYMNOSTOMATA, in which the mouth is closed except when the food is being ingested, and (2) the TRICHOSTOMATA, in which the mouth is always open and provided with an undulating membrane. Schewiakoff divided the class CILIATA into the order ASPIROTRICHA (=order HOLOTRICHA St., with the addition of some

families formerly referred to the orders HYPOTRICHA (e g, Ervilina and Chlamydodonta) and PERITRICHA (Cyclo dinina)), and SPIROTRICHA, including the suborders HETEROTRICHA, OLIGOTRICHA, HYPOTRICHA, and PERITRICHA He recognized the distinct position of the Opalinidæ, and divided his order ASPIROTRICHA into GYMNOSTOMATA, TRICHOSTOMATA, and ASTOMATA, and arranged the families included under GYMNOSTOMATA in accordance with the position of the mouth into three tribes, which he called PROSTOMATA, PLEUROSTOMATA, and HYPOSTOMATA The GYMNOSTOMATA comprised eleven families, the TRICHOSTOMATA seven families, and the ASTOMATA one family Delage gave the name HYMENOSTOMATA to TRICHOSTOMATA of Schewiakoff, and Hickson in the main followed Schewiakoff's classification, but used the term HYMENOSTOMATA for TRICHOSTOMATA, and for no valid reason included Opalininæ under this group instead of as a special group as Schewiakoff had done Chatton and Lwoff have established THIGMOTRICHA and APOSTOMEA as new suborders of HOLOTRICHA

Ray Lankester (1870) was the first to recognize that the grouping of *Opalina* with the other astomatous Ciliates was an unnatural procedure, and Léger and Duboscq (1904) maintained that the ASTOMATA, as defined till then, did not constitute a natural group, their apparent resemblance being a case of convergence due to parasitism They separated the Opalininæ from the Anoplophryidæ This view was accepted by Cépède (1910), who divided the astomatous Ciliates into eleven families Hartog (1906) went so far as to remove the Opalininæ from the class CILIATA and place it with the trichonymphids among the MASTIGOPHORA Minchin, Doflein and other authors have, however, not accepted this view To do justice to the fundamental differences of nuclear structure Metcalf (1920, 1923) has separated the Opalinidæ from the rest of the Ciliates and divided the class into two subclasses, viz, PROTOCILIATA and EUCILIATA, a scheme which is now generally followed

The SPIROTRICHA of Schewiakoff corresponded with Butschli's suborder of the same name, and included HETEROTRICHA, OLIGOTRICHA, HYPOTRICHA and PERITRICHA—that is, all the Ciliates which possess a special adoral zone of cilia arranged in a spiral manner in front of the mouth There are, however, a number of fundamental differences between the HETEROTRICHA, OLIGOTRICHA and HYPOTRICHA on the one hand and the PERITRICHA on the other The adoral zone of membranelles in the first three orders turns to the left if viewed from the ventral or oral side (taking the oral end of the spiral as its beginning), but in PERITRICHA (with few exceptions) the adoral zone, if viewed from the ventral side, turns to the right, or, as generally stated, forms a right-handed spiral As,

however, we are dealing with organs which are not developed from the mouth, but play the physiological rôle of carrying the food to the mouth, Reichenow (1929) considers it more reasonable that the end of the adoral zone furthest from the mouth should be regarded as its beginning So viewed, it may be described as turning to the left in the PERITRICHA and to the right in the HETEROTRICHA, OLIGOTRICHA and HYPOTRICHA How this reversal of the adoral spiral came about has been discussed among others by Butschli (1887–89) and Fauré-Fremiet (1905) Butschli explained the phylogenetic origin of the PERITRICHA from flattened hypotrichous forms in which the ventral surface came to serve for attachment while the peripheral region of the adoral zone became turned over to the side and finally on to the dorsal aspect The functional ventral (oral) surface of a Vorticellid is thus the morphological dorsal surface, and the attaching surface is the morphological ventral surface The seeming longitudinal splitting is thus really transverse in a morphological sense Colony formation, separation of individual cells provided with a temporary ciliated girdle, occurrence of dimorphic gametes and their complete and permanent fusion during fertilization are remarkable features characteristic of the PERITRICHA alone among the Ciliates

It is now generally believed that, taking the HOLOTRICHA as the more primitive Ciliates, the HETEROTRICHA and the PERITRICHA are derived from them by separate routes From the HETEROTRICHA are derived the OLIGOTRICHA and HYPOTRICHA To give expression to this view in classification Kahl has recently emended SPIROTRICHA Butschli so as to exclude the PERITRICHA, and Reichenow (1929) has followed him Reichenow has also separated the parasitic forms belonging to the families Ophryoscolecidæ and Cycloposthiidæ from the OLIGOTRICHA, and placed them in a separate suborder ENTODINIOMORPHA, and certain aberrant sapropelic forms belonging to the family Ctenostomidæ have also been placed under a separate suborder by Kahl

The highly specialized forms in which the peristomial area with the adoral zone of membranelles is spirally rolled have been placed in a separate order CHONOTRICHA I have followed Kahl and Reichenow in this new classification

The CILIOPHORA are thus divided into the following classes, orders and suborders —

I Class CILIATA Bütschli

I Subclass PROTOCILIATA Metcalf

II Subclass EUCILIATA Metcalf

1 Order HOLOTRICHA Stein

1 Suborder GYMNOSTOMATA Butschli
2 Suborder TRICHOSTOMATA Butschli, em Kahl

3 Suborder HYMENOSTOMATA Hickson, em Kahl
4 Suborder THIGMOTRICHA Chatton & Lwoff
5 Suborder APOSTOMEA Chatton & Lwoff
6 Suborder ASTOMATA Schewiakoff, em Cépede

2 Order SPIROTRICHA Butschli, em Kahl
1 Suborder HETEROTRICHA Stein
2 Suborder OLIGOTRICHA Butschli
3 Suborder ENTODINIOMORPHA Reichenow
4 Suborder CTENOSTOMIDA Kahl
5 Suborder HYPOTRICHA Stein

3 Order PERITRICHA Stein

4 Order CHONOTRICHA Wallengren

II Class SUCTORIA Butschli

The further classification into families, and the genera and species dealt with, will be seen from the Systematic Index

The Geographical Distribution of Indian Ciliophora

It is well known that species of freshwater and soil PROTOZOA are cosmopolitan The majority of the 310 species now known from India are found in Europe and America, and those that have been described as new in the present work are likely to be found in other parts of the world also This is due to the fact that the conditions of life in pools and ponds are much the same all over the world, and the freshwater forms, especially in an encysted state, can be easily carried from one place to another by wind or by animals

I have followed the regional divisions of India as adopted by Stephenson in his volume on Oligochæta in the 'Fauna of British India,' and have noted the species so far recorded from each of these divisions, but no importance can be attached to the apparent presence or absence of any species from the different regions The larger number of species recorded from certain regions is due simply to the fact that these regions have been better explored, and further work will doubtless show the "all-India" distribution of most of the species The lists will, however, be of some use to workers in different parts of the country, and enable them to make a more thorough search than has hitherto been made

1 NORTH-WESTERN TERRITORY

(The drainage system of the Indus, so far as comprised in the plains of India, the Punjab, N W Frontier Province, N Rajputana, Sind)

OPALINIDÆ

Cepedea metcalfi (Lahore)
,, *punjabensis* (Lahore)
,, *sialkoti* (Sialkot)

Opalina coracoidea (Lahore)
,, *lata* (Lahore)
,, *ranarum* (Lahore)

HOLOPHRYIDÆ

Holophrya indica (Lahore)
,, *simplex* (Lahore)
Urotricha globosa (Lahore)
Prorodon teres (Lahore)
, *edentatus* (Lahore)
Lacrymaria vermicularis (Lahore)
,, *striata* (Lahore)
Enchelys arcuata (Lahore)
,, sp (Lahore, Lyallpore)

DIDINIIDÆ

Didinium nasutum (Lahore)
,, *balbiani* (Lahore)

COLEPIDÆ

Coleps hirtus (Lahore)
,, *kenti* (Lahore)
uncinatus (Lahore)

SPATHIDIIDÆ

Spathidium moniliforme (Lahore)

AMPHILEPTIDÆ

Lionotus fasciola (Lahore)
,, *pleurosigma* (Lahore)
Loxophyllum meleagris (Lahore)

TRACHELIIDÆ

Dileptus anser (Lahore)

LOXODIDÆ

Loxodes punjabensis (Lahore)

NASSULIDÆ

Nassula stromphii (Lahore)
,, *ambigua* (Lahore)
Cyclogramma rubens (Lahore)

CHLAMYDODONTIDÆ

Chilodonella cucullulus (Lahore)

COLPODIDÆ

Colopoda cucullus (Lahore, Gurdaspur, Peshawar, Karachi).
,, *steinii* (Lahore, Peshawar)

PARAMECIIDÆ

Paramecium caudatum (Lahore)

FRONTONIDÆ

Frontonia leucas (Lahore)
Sigmostomum indicum (Lahore)
Trichoda pura (Lahore)
Glaucoma scintillans (Lahore)
Colpidium colpoda (Lahore)
,, *campyllum* (Lahore)
,, *striatum* (Lahore)
,, sp (Peshawar)
Pseudoglaucoma digitata (Lahore)

PLEURONEMATIDÆ

Cyclidium glaucoma (Lahore)
Balantiophorus elongatus (Lahore, Gurdaspur, Jullundhur Peshawar)
Balantiophorus minutus (Lahore Jullundhur, Peshawar)
,, sp (Lahore)

UROCENTRIDÆ

Urocentrum turbo (Lahore)
Telotrichidium mathaii (Lahore)

ANOPLOPHRYIDÆ

Maupasella nova (Lahore)

SPIROSTOMIDÆ

Spirostomum ambiguum (Lahore)

PLAGIOTOMIDÆ

Nyctotherus cordiformis (Lahore)
,, *macropharyngeus* (Lahore)
,, *ovalis* (Lahore)
,, *reniformis* (Sialkot)

STENTORIDÆ

Stentorella polymorphus (Lahore)
,, sp (Lahore)

BURSARIDÆ

Bursaria truncatella (Lahore)

BALANTIDIIDÆ

Balantidium amygdalli (Sialkot)
,, *bicavata* (Lahore)
, *blattarum* (Lahore)
,, *duodeni* (Lahore)
,, *elongatum* (Lahore)
,, *gracile* (Lahore)
,, *helenæ* (Lahore)

HALTERIIDÆ

Halteria grandinella (Lahore)
,, sp (Peshawar)

PERITROMIDÆ

Peritromoides simplex (Lahore)

OXYTRICHIDÆ

Urostyla weissi (Lahore)
Uroleptus sp (Peshawar)
Gonostomum affine (Lahore Jullundhur ?)
Pleurotricha grandis (Lahore, Peshawar)
,, *lanceolata* (Peshawar)
Gastrostyla setifera (Lahore)
Oxytricha pellionella (Lahore, Jullundhur ?)
Stylonichia pustulata (Lahore)

ASPIDISCIDÆ

Aspidisca lynceus (Lahore)
,, *costata* (Lahore)

VORTICELLIDÆ

Scyphidia indica (Lahore)
Vorticella campanula (Lahore)
„ *citrina* (Lahore)
„ *microstoma* (Peshawar)
Carchesium epistylidis (Lahore)
Epistylis plicatilis (Lahore)
„ *articulata* (Lahore)

PODOPHRYIDÆ

Sphærophrya pusilla (Lahore, Hoshiarpur)

2 WESTERN HIMALAYAN REGION

(From Hazara to the border of Nepal, including Kashmir)

COLEPIDÆ

Coleps hirtus (Srinagar)

AMPHILEPTIDÆ

Lionotus fasciola (Srinagar)
Loxophyllum helus (Srinagar)

LOXODIDÆ

Loxodes striatus (Srinagar)
„ *bahaduri* (Srinagar)

CHLAMYDODONTIDÆ

Chilodonella cucullulus (Srinagar)
„ *spiralidentis* (Srinagar)

COLPODIDÆ

Colpoda cucullus (Ghora Gali, Srinagar)
„ *steinii* (Ghora Gali, Srinagar)

PARAMECIIDÆ

Paramecium caudatum (Srinagar)
„ *aurelia* (Srinagar)
„ *bursaria* (Srinagar)

FRONTONIDÆ

Glaucoma pyriformis (Srinagar)
Colpidium sp (Ghora Gali, Srinagar)

PLEURONEMATIDÆ

Balantiophorus elongatus (Ghora Gali, Srinagar)

UROCENTRIDÆ

Urocentrum turbo (Srinagar)

SPIROSTOMIDÆ

Spirostomum ambiguum (Srinagar)
„ *teres* (Srinagar)

STENTORIDÆ

Stentorella polymorpha (Srinagar)

OXYTRICHIDÆ

Uroleptus mobilis (Ghora Gali, Srinagar)
,, *piscis* (Srinagar)
Gonostomum affine (Srinagar)
Pleurotricha grandis (Ghora Gali)
,, *lanceolata* (Ghora Gali, Srinagar)
Stylopichia pustulata (Srinagar)

VORTICELLIDÆ

Vorticella microstoma (Ghora Gali, Srinagar)
,, sp (Ghora Gali)

3 NORTH EASTERN FRONTIER REGION

(Nepal and eastwards, including Assam)

COLPODIDÆ

Colpoda cucullus (Assam)

PLEURONEMATIDÆ

Balantiophorus elongatus (Cinnamara near Jorhat)

BALANTIDIIDÆ

Balantidium coli var *bovis* (Assam)

OXYTRICHIDÆ

Gonostomum sp (Dacca)
Pleurotricha grandis (Assam)

4 INDO-GANGETIC PLAIN

(United Provinces, Bihar, Bengal)

OPALINIDÆ

Opalina plicata (Calcutta)
,, *scalpriformis* (Calcutta)
,, *triangularis* (Calcutta)

HOLOPHRYIDÆ

Holophrya annandalei (Calcutta)
,, *bengalensis* (Calcutta)
Urotricha sp (Calcutta)
Prorodon stewarti (Calcutta)
Lacrymaria olor (Calcutta)
Enchelis sp (Sibpore)
Trachelocerca sp (Calcutta)

COLEPIDÆ

Coleps hirtus (Calcutta)
,, sp (Calcutta)

AMPHILEPTIDÆ

Amphileptus sp (Calcutta)
Lionotus fasciola (Calcutta)
,, *similis* (Calcutta)
,, *infusionus* (Calcutta)

LOXODIDÆ

Loxodes sp (Calcutta)

TRACHELIIDÆ

Trachelius gutta (Calcutta)

NASSULIDÆ

Chilodontopsis bengalensis (Calcutta)
Orthodonella banerjeei (Calcutta)

CHLAMYDODONTIDÆ

Chilodonella rhesus (Calcutta)
,, sp (Calcutta)
,, sp (Sibpore)

COLPODIDÆ

Colpoda cucullus (Delhi, Agra, Dehra Dun, Sibpore, Calcutta, Dacca, Cuttack, Pusa)
,, *steinii* (Delhi, Dehra Dun)
,, *maupasi* (Pusa)

FRONTONIDÆ

Colpidium sp (Chittagong)

PARAMECIIDÆ

Paramecium caudatum (Calcutta, Lucknow)
,, sp (Calcutta)

TRICHOPELMIDÆ

Drepanomonas dentata (Calcutta)

Incertæ sedis

Opisthostomum bengalensis (Calcutta)

CONCHOPHTHIRIDÆ

Conchophthirius curtus (Calcutta)
,, *lamellidens* (Calcutta)
,, *elongatus* (Calcutta)

ISOTRICHIDÆ

Isotricha prostoma (Calcutta)
Dasytricha ruminantium (Calcutta)

FRONTONIDÆ

Colpidium sp (Dehra Dun, Agra, Patna, Dacca)
Stegochilum ovale (Calcutta)

PLEURONEMATIDÆ

Cyclidium glaucoma (Sibpore)
Pleuronema chrysalis (Calcutta)
Balantiophorus elongatus (Benares, Agra, Patna, Sibpore, Calcutta, Chittagong)
,, *minutus* (Dehra Dun, Patna, Sibpore, Calcutta, Chittagong),

ANOPLOPHRYIDÆ

Anoplophrya ælosomata (Calcutta)
,, *cylindrica* (Calcutta)
,, *elongata* (Calcutta)
,, *lloydi* (Calcutta)
,, *variabilis* (Calcutta)

SPIROSTOMIDÆ

Spirostomum ambiguum (Calcutta)
,, sp (Agra)

PLAGIOTOMIDÆ

Nyctotherus cordiformis (Calcutta)
,, *kempi* (Calcutta)
,, *macropharyngeus* (Calcutta)

STENTORIDÆ

Stentorella polymorphus (Calcutta)
,, *viridis* (Calcutta)

FOLLICULINIDÆ

Folliculina ampulla (Port Canning, Lower Bengal)

BURSARIDÆ

Parabursaria pheretima (Calcutta)

BALANTIDIIDÆ

Balantidium blattarum (Calcutta)
,, *coli* (Calcutta)
,, *depressum* (Calcutta)
,, *knowlesii* (Calcutta)
,, *ovatum* (Calcutta)
,, *ranarum* (Calcutta)
,, *rhesum* (Calcutta)
,, *sushilii* (Calcutta)

OPHRYOSCOLECIDÆ

Entodinium bursa (Calcutta)
,, *dubardi* (Calcutta)
,, *lobosospinosum* (Calcutta)
,, *longinucleatum* (Calcutta)
,, *biconcavum* (Calcutta)
,, *elongatum* (Calcutta)
,, *laterale* (Calcutta)
,, *rectangulatum* (Calcutta)
,, *anteronucleatum læve* (Calcutta)
,, ,, *monolobum* (Calcutta)
,, ,, *dilobum* (Calcutta)
,, *caudatum* (Calcutta)
,, *chatterjeei* (Calcutta)
,, *ekendræ* (Calcutta)
,, *furca dilobum* (Calcutta)
,, *nanellum* (Calcutta)
,, *ovinum* (Calcutta)
,, *ovoido nucleatum* (Calcutta)
,, *setnai* (Calcutta)
,, *simplex* (Calcutta)
Diplodinium anisacanthum (Calcutta)
,, *consors* (Calcutta)
,, *costatum* (Calcutta)
,, *crista galli* (Calcutta)
Eremoplastron rostratum (Calcutta)
,, *brevispinum* (Calcutta)
Eudiplodinium maggii (Calcutta)
Diploplastron affine (Calcutta)

Metadinium medium (Calcutta)
Elytroplastron bubali (Calcutta)
Epidinium ecaudatum (Calcutta)
,, *caudatum* (Calcutta)
,, *cattanei* (Calcutta)
Ophryoscolex tricoronatus (Calcutta)

OXYTRICHIDÆ

Uroleptus mobilis (Chittagong)
Gonostomum affine (Delhi, Agra)
Pleurotricha grandis (Agra, Sibpore)
,, *lanceolata* (Delhi)
Stylonichia sp (Agra, Calcutta)
Balladinopsis nuda (Calcutta)

EUPLOTIDÆ

Euplotes sp (Calcutta)

ASPIDISCIDÆ

Aspidisca costata (Lucknow)
Aspidiscopsis bengalensis (Calcutta)

VORTICELLIDÆ

Scyphidia purniensis (Purnea, Bengal).
Vorticella patellina (Calcutta)
,, *globosa* (Calcutta)
,, *subcylindrica* (Calcutta)
,, *submicrostoma* (Calcutta)
,, *subprocubens* (Calcutta)
,, *subsinuata* (Calcutta)
,, sp (Calcutta)
Carchesium polypinum (Port Canning, Lower Bengal)
,, sp (Calcutta)
Epistylis sp (Calcutta)
Cothurnia sp (Calcutta)
Vaginicola sp (Calcutta)
Platycola sp (Calcutta)

ACINETIDÆ

Tokophrya bengalensis (Calcutta)

PODOPHRYIDÆ

Podophrya bengalensis (Calcutta)
,, *sandi* (Calcutta)

5 BURMA

(Including the Andamans and Nicobars)

COLPODIDÆ

Colpoda cucullus (Hmawbi)
,, *steinii* (Rangoon, Hmawbi)

PLEURONEMATIDÆ

Pleuronema sp (Hmawbi)

OXYTRICHIDÆ

Uroleptus mobilis (Rangoon)

6 MAIN PENINSULAR AREA

(Including S Rajputana and the Central India Agency)

HOLOPHRYIDÆ

Prorodon sp (Indore)

AMPHILEPTIDÆ

Lionotus sp (Indore)

CHLAMYDODONTIDÆ

Chilodonella sp (Indore)

COLPODIDÆ

Colpoda cucullus (Nagpur, Hyderabad)
,, *steinii* (Indore, Nagpur, Hyderabad)

PLEURONEMATIDÆ

Balantiophorus elongatus (Indore, Cuttack)

SPIROSTOMIDÆ

Blepharisma sp (Indore)
Spirostomum sp (Indore, Hyderabad)

HALTERIIDÆ

Halteria sp (Indore)

OXYTRICHIDÆ

Stichotricha sp (Indore)
Uroleptus mobilis (Indore)
,, *piscis* (Indore)
,, sp (Indore)
Pleurotricha grandis (Indore)
,, *lanceolata* (Indore, Hyderabad)
Oxytricha pellionella (Indore)

VORTICELLIDÆ

Vorticella microstoma (Indore)
,, sp (Indore)

7 SOUTHERN REGION

(S of Latitude 15°)

HOLOPHRYIDÆ

Enchelys sp (Coimbatore)

COLPODIDÆ

Colpoda cucullus (Madras, Mysore, Coimbatore)
,, *steinii* (Madras, Mysore, Coimbatore)
,, *maupasi* (Madras, Coimbatore)

ISOTRICHIDÆ

Isotricha intestinalis (Mysore)
,, *prostoma* (Mysore, Coonoor)
Dasytricha ruminantium (Coonoor)

FRONTONIDÆ

Colpidium striatum (Mysore)
Uronema marinum (Mysore)
,, *accuminata* (Mysore)

PLEURONEMATIDÆ

Balantiophorus elongatus (Coimbatore Kanara)
,, *minutus* (Coimbatore)

HAPTOPHRYIDÆ

Caudalina bangalorensis (Mysore)
,, *armata* (Mysore)

SPIROSTOMIDÆ

Spirostomum sp (Madras)

CONDYLOSTOMIDÆ

Condylostoma patens (Mysore)

Incertæ sedis

Octocirrus sphæratus (Mysore)

OPHRYOSCOLECIDÆ

Entodinium curtum (Mysore)
,, *ellipsoideum* (Coonoor)
,, *longinucleatum* (Coonoor, Mysore)
,, *acutonucleatum* (Coonoor, Mysore)
,, *contractum* (Mysore)
,, *rostratum* (Coonoor)
,, *pisciculum* (Coonoor)
,, *biconcavum* (Coonoor)
,, *bifidum* (Coonoor)
,, *acutum* (Coonoor)
,, *laterale* (Coonoor)
,, *rectangulatum* (Coonoor)
,, *brevispinum* (Coonoor)
,, *laterospinum* (Coonoor)
,, *nanellum* (Coonoor, Mysore)
,, *ovoideum* (Coonoor)
,, *rhomboideum* (Coonoor)
,, *bismatus* (Coonoor)
,, *gibberosum* (Coonoor)
,, *tricostatum* (Coonoor)
,, *indicum* (Coonoor, Mysore)
Eodinium lobatum (Coonoor)
,, *bilobosum* (Mysore)
,, *rectangulatum* (Coonoor)
Diplodinium dentatum (Coonoor)
,, *monacanthum* (Coonoor)
,, *diacanthum* (Mysore)
,, *triacanthum* (Mysore)
,, *tetracanthum* (Mysore)
,, *pentacanthum* (Mysore)
,, *anisacanthum* (Mysore)
,, *psittaceum* (Coonoor)
,, *minor* (Mysore)
,, *flabellum* (Coonoor)

OPHRYOSCOLECIDÆ (*cont.*)

Eremoplastron rostratum (Mysore)
,, *rotundum* (Coonoor)
,, *bovis* (Coonoor)
,, *magnodentatum* (Coonoor)
Eudiplodinium maggii (Coonoor, Mysore)
Metadinium medium (Coonoor Mysore)
,, *rotundatum* (Mysore)
Elytroplastron bubali (Coonoor)
Ostracodinium gauri (Mysore)
,, *mysorei* (Mysore)
,, *mammosum* (Coonoor)
,, *gracile* (Coonoor, Mysore)
,, *trivesiculatum* (Coonoor, Mysore)
,, *quadrivesiculatum* (Coonoor)
,, *venustum* (Coonoor)
,, *clipeolum* (Coonoor)
,, *rugoloricatum* (Coonoor)
Epidinium caudatum (Mysore)
,, *quadricaudatum* (Mysore)
,, *parvicaudatum* (Mysore)
,, *cattanei* (Coonoor)
,, *eberleini* (Coonoor)
Ophryoscolex spinosus (Coonoor)
Polydinium mysoreum (Mysore)
Elephantophilus zeta (Mysore)

OXYTRICHIDÆ

Uroleptus mobilis (? Coimbatore)
,, *piscis* (Coimbatore)
Gonostomum affine (Kanara, Coimbatore)
Pleurotricha lanceolata (Kanara, Madras)
Oxytricha sp (Coimbatore)

EUPLOTIDÆ

Euplotes charon (Mysore)

VORTICELLIDÆ

Vorticella microstoma (Coimbatore, Mysore)
Carchesium polypinum (Mysore)
Vaginicola sp (Bangalore)

8 WESTERN REGION

(Goa to Cutch, the Ghats to the Sea)

OPALINIDÆ

Cepedea longa (Nova Goa)
,, *seychellensis* var *angusta* (Nova Goa)
,, *subcylindrica* (Nova Goa)
,, *thiagi* (Nova Goa)
Opalina scalpriformis (Nova Goa)
,, *triangularis* (Nova Goa)
,, *ranarum* (Nova Goa)
,, *lata* (Nova Goa)
,, ,, var *cordata* (Nova Goa)
,, *coracoidea* (Nova Goa)
virgula (Nova Goa)

HOLOPHRYIDÆ
Holophrya lateralis (Bombay)
Urotricha sp (Bombay)

DIDINIIDÆ
Mesodinium pulex (Bombay)

NASSULIDÆ
Nassula sp (Bombay)

CHLAMYDODONTIDÆ
Chilodonella cucullulus (Bombay)

PLAGIOPYLIDÆ
Plagiopyla carteri (Bombay)

COLPODIDÆ
Colpoda cucullus (Bombay, Dharwar)
,, *steinii* (Bombay, Poona, Kanara, Dharwar)

PARAMECIIDÆ
Paramecium aurelia (Bombay)

FRONTONIDÆ
Frontonia leucas (Bombay)

OPHRYOGLENIDÆ
Ophryoglena flava (Bombay)

PLEURONEMATIDÆ
Balantiophorus elongatus (Dharwar)
,, *minutus* (Dharwar)

UROCENTRIDÆ
Urocentrum turbo (Bombay)

PLAGIOTOMIDÆ
Nyctotherus cordiformis (Nova Goa)
,, *macropharyngeus* (Bombay, Nova Goa)
,, *magnus* var *malabarica* (Nova Goa)
,, *ovalis* (Nova Goa)
,, *papillatus* (Nova Goa)

BALANTIDIIDÆ
Balantidium gracile (Nova Goa)
,, *helenæ* (Nova Goa)

STENTORIDÆ
Climacostomum virens (Bombay)
Stentorella sp (Bombay)

OXYTRICHIDÆ
Gonostomum affine (Dharwar)
Pleurotricha grandis (Bombay)
Oxytricha sp (Bombay)

EUPLOTIDÆ
Euplotes charon (Bombay)

VORTICELLIDÆ

Vorticella convallaria (Bombay)
,, *microstoma* (Bombay)
,, sp (Bombay)
Epistylis galea (Bombay)
Pyxicola carteri (Bombay)

ACINETIDÆ

Tokophrya quadripartita (Bombay)
Acineta tuberosa (Bombay)

PODOPHRYIDÆ

Podophrya fixa (Bombay)
Sphærophrya sp (Bombay)

9 CEYLON.

OPALINIDÆ

Opalina virgula (Peradeniya)

HOLOPHRYIDÆ

Prorodon sp (Colombo)

AMPHILEPTIDÆ

Lionotus sp (Colombo)

NASSULIDÆ

Phascolodon sp (Colombo)

COLPODIDÆ

Colpoda cucullus (Kandy)

ISOTRICHIDÆ

Isotricha prostoma (Colombo)
Dasytricha ruminantium (Colombo)

PARAISOTRICHIDÆ

Blepharocorys ventriculi (Colombo)

FRONTONIDÆ

Colpidium sp (Colombo)

PLEURONEMATIDÆ

Balantiophorus sp (Colombo)

PLAGIOTOMIDÆ

Nyctotherus macropharyngeus (Colombo)
,, *papillatus* (Paradeniya)
,, *termitis* (Colombo)

BALANTIDIIDÆ

Balantidium duodeni (Colombo)
,, *helenæ* (Colombo)
,, *testudinis* (Colombo)

TINTINNIDÆ

Tintinnopsis ovalis (Madatugama)
,, *lacustris* (Madatugama, Lake Kalawewa)

OPHRYOSCOLECIDÆ

Entodinium ellipsoideum (Colombo)
,, *longinucleatum* (Colombo)
,, *acutonucleatum* (Colombo)
,, *rostratum* (Colombo)
,, *pisciculum* (Colombo)
,, *biconcavum* (Colombo)
,, *acutum* (Colombo)
,, *aculeatum* (Colombo)
,, *laterale* (Colombo)
,, *rectangulatum* (Colombo)
,, *brevispinum* (Colombo)
,, *laterospinum* (Colombo)
,, *nanellum* (Colombo)
,, *ovoideum* (Colombo)
,, *rhomboideum* (Colombo)
,, *bimatus* (Colombo)
,, *gibberosum* (Colombo)
,, *tricostatum* (Colombo)
,, *indicum* (Colombo)
,, *ovalis* (Colombo)
,, *bursa* (Colombo)
,, *dubardi* (Colombo)
Eodinium lobatum (Colombo)
,, *rectangulatum* (Colombo)
Diplodinium dentatum (Colombo)
,, *monocanthum* (Colombo)
,, *psittaceum* (Colombo)
Eremoplastron rostratum (Colombo)
,, *rotundum* (Colombo)
,, *bovis* (Colombo)
,, *brevispinum* (Colombo)
,, *magnodentatum* (Colombo)
,, *maggii* (Colombo)
Metadinium medium (Colombo)
Elytroplastron bubali (Colombo)
Ostracodinium mammosum (Colombo)
,, *gracile* (Colombo)
,, *trivesiculatum* (Colombo)
,, *quadrivesiculatum* (Colombo)
,, *venustum* (Colombo)
,, *clipeolum* (Colombo)
,, *rugoloricatum* (Colombo)
Epidinium ecaudatum (Colombo)
,, *caudatum* (Colombo)
,, *bicaudatum* (Colombo)
,, *tricaudatum* (Colombo)
,, *quadricaudatum* (Colombo)
,, *cattanei* (Colombo)
,, *eberleini* (Colombo)

OXYTRICHIDÆ

Holosticha mystacea (Kandy)
Gonostomum affine (Colombo)
Stylonichia pustulata (Kandy)

VORTICELLIDÆ

Epistylis anastatica

Distribution of Parasitic Forms

Unlike the freshwater PROTOZOA, the geographical distribution of parasites usually follows that of their hosts. Up to the present time only a very small number of animals found in India have been examined for their parasites, and a more extensive survey is highly desirable. The following lists of (i) parasites and their hosts, and (ii) the hosts and their parasites, will, it is hoped, be found useful, and indicate at a glance which of our commoner animals still remain to be examined for their parasites.

(i) *List of Parasites and their Hosts*

Parasite	Host	Seat
Zelleriella macronucleata	*Bufo melanostictus*	Rectum
Cepedea lanceolata	*Rana esculenta* var *chinensis*	Rectum
Cepedea longa	*Rana limnocharis*	Rectum
	Rhacophorus maculatus	Intestine
Cepedea metcalfi	*Bufo melanostictus*	Rectum
Cepedea punjabensis	*Bufo melanostictus*	Rectum
Cepedea seychellensis var *angusta*	*Rana tigrina*	Intestine
	Bufo melanostictus	Intestine
Cepedea sialkoti	*Bufo macrotis*	Rectum
Cepedea subcylindrica	*Bufo melanostictus*	Intestine
Cepedea thiagi	*Rhacophorus maculatus*	Intestine
Opalina coracoidea	*Rana cyanophlyctis*	Intestine
Opalina coracoidea lahorensis	*Rana tigrina*	Rectum
	Bufo melanostictus	Rectum
Opalina lata	*Rana limnocharis*	Intestine and rectum
	Rana hexadactyla	Rectum
Opalina lata var *cordata*	*Rana cyanophylctis*	Intestine
	Rana malabarica	Intestine
Opalina plicata	*Bufo melanostictus*	Rectum
Opalina ranarum	*Rana esculenta*	Rectum
	Rana cyanophlyctis	Intestine and rectum
	Rana tigrina	Intestine
	Bufo cinereus	Rectum
	Bufo melanostictus	Intestine
	Bufo variabilis	Rectum
Opalina scalpriformis	*Bufo melanostictus*	Rectum and intestine
Opalina triangularis	*Bufo melanostictus*	Rectum and intestine
Opalina virgula	*Polypedates (Rhacophorus) maculatus*	Rectum
	Bufo melanostictus	Intestine
Chilodonella rhesus	*Macacus rhesus*	Intestine
Conchopthirius curtus	*Lamellidens marginalis*	Mantle chamber
Conchopthirius lamellidens	*Lamellidens marginalis*	Mantle chamber
Conchopthirius elongatus	*Lamellidens marginalis*	Mantle chamber

Parasite	Host	Seat
Isotricha intestinalis	*Bos gaurus*	Stomach
Isotricha prostoma	*Bos gaurus*	Stomach
	Bos indicus	Stomach
	Capra hircus	Rumen
Dasytricha ruminantium	*Bos indicus*	Stomach
	Capra hircus	Rumen
Blepharocorys ventriculi	*Bos indicus*	Stomach
Anoplophrya ælosomatis	*Ælosoma chlorostictum*	Alimentary canal
Anoplophrya cylindrica	*Vivipara bengalensis*	Intestinal canal
Anoplophrya elongata	Small freshwater gastropods	Rectum
Anoplophrya lloydii	*Pheretima posthuma*	Seminal vesicles
Anoplophrya variabilis	Small freshwater gastropods	Intestine
Maupasella nova	*Pheretima posthuma*	Alimentary canal
	Pheretima hawayana	Alimentary canal
Nyctotherus cordiformis	*Bufo melanostictus*	Intestine and cloaca
	Rana tigrina	Intestine
	Rana malabarica	Intestine
	Rana limnocharis	Intestine
Nyctotherus kempi	*Ampullaria globosa*	Rectum
Nyctotherus macropharyngeus	*Rana tigrina*	Intestine and cloaca
	Rana cyanophlyctis	Intestine and cloaca
	Rana hexadactyla	Cloaca
	Rana limnocharis	Intestine
Nyctotherus magnus	*Rana hexadactyla*	Cloaca
Nyctotherus magnus var *malabarica*	*Rana tigrina*	Intestine
Nyctotherus ovalis	*Periplaneta americana*	Mid- and hind-gut
Nyctotherus papillatus	*Bufo melanostictus*	Cloaca
	Rhacophorus maculatus	Intestine and cloaca
Nyctotherus reniformis	*Bufo macrotis*	Rectum
Nyctotherus termitis	*Calotermes militaris*	Intestine
Paraburaaria pheretima	*Pheretima posthuma*	Seminal vesicles
Balantidium amygdalli	*Bufo macrotis*	Rectum
Balantidium bicavata	*Bufo melanostictus*	Rectum
Balantidium blattarum	*Periplaneta americana*	Intestine
Balantidium coli	*Homo sapiens*	Intestine
Balantidium coli var *bovis*	Cattle	Intestine
Balantidium depressum	*Ampullaria globosa*	Rectum
Balantidium duodeni	*Rana tigrina*	Duodenum and small intestine
Balantidium elongatum	*Rana tigrina*	Intestine
Balantidium gracile	*Rana cyanophlyctis*	Rectum
	Rana hexadactyla	Rectum
	Rana tigrina	Small intestine
Balantidium helenæ	*Rana tigrina*	Intestine and rectum
	Rana cyanophlyctis	Intestine
	Rana limnocharis	Intestine
Balantidium giganteum	*Rana esculenta* var *chinensis*	Cloaca
Balantidium knowlesii	*Culicoides peregrinus*	Cœlom
Balantidium ovatum	*Periplaneta americana*	Intestine

Parasite	Host	Seat
Balantidium ranarum	*Rana tigrina*	Rectum
Balantidium rhesum	*Macacus rhesus*	Intestine
Balantidium rotundum	*Rana esculenta* var *chinensis*	Small intestine
Balantidium sushilii	*Rana tigrina*	Intestine
Balantidium testudinis	*Nicoria trijuga*	Large intestine
Entodinium bursa	*Tragulus meminna*	Stomach
	Capra hircus	Rumen
Entodinium curtum	*Bos gaurus*	Stomach
Entodinium dubardi	*Tragulus meminna*	Stomach
	Capra hircus	Rumen
Entodinium lobosospinosum	*Capra hircus*	Rumen
Entodinium ellipsoideum	*Bos indicus*	Stomach
Entodinium longinucleatum	*Bos indicus*	Stomach
	Bos gaurus	Stomach
	Capra hircus	Rumen
Entodinium acutonucleatum	*Bos indicus*	Stomach
	Bos gaurus	Stomach
Entodinium rostratum	*Bos indicus*	Stomach
Entodinium pisciculum	*Bos indicus*	Stomach
Entodinium biconcavum	*Bos indicus*	Stomach
	Capra hircus	Rumen
Entodinium elongatum	*Capra hircus*	Rumen
Entodinium bifidum	*Bos indicus*	Stomach
Entodinium acutum	*Bos indicus*	Stomach
Entodinium aculeatum	*Bos indicus*	Stomach
Entodinium laterale	*Bos indicus*	Stomach
	Capra hircus	Rumen
Entodinium rectangulatum	*Bos indicus*	Stomach
	Capra hircus	Rumen
Entodinium anteronucleatum læve	*Capra hircus*	Rumen
Entodinium anteronucleatum monolobum	*Capra hircus*	Rumen
Entodinium anteronucleatum dilobum	*Capra hircus*	Rumen
Entodinium bismatus	*Bos indicus*	Stomach
Entodinium brevispinum	*Bos indicus*	Stomach
Entodinium caudatum	*Capra hircus*	Rumen
Entodinium chatterjeei	*Capra hircus*	Rumen
Entodinium contractum	*Bos gaurus*	Stomach
Entodinium ekendræ	*Capra hircus*	Rumen
Entodinium furca dilobum	*Capra hircus*	Rumen
Entodinium gibberosum	*Bos indicus*	Stomach
Entodinium indicum	*Bos gaurus*	Stomach
	Bos indicus	Stomach
Entodinium laterospinum	*Bos indicus*	Stomach
Entodinium nanellum	*Bos gaurus*	Stomach
	Bos indicus	Stomach
	Capra hircus	Rumen
Entodinium ovalis	*Tragulus meminna*	Stomach
Entodinium ovinum	*Capra hircus*	Rumen
Entodinium ovoideum	*Bos indicus*	Stomach
Entodinium ovoido nucleatum	*Capra hircus*	Rumen
Entodinium rhomboideum	*Bos indicus*	Stomach

Parasite	Host	Seat
Entodinium setnai	*Capra hircus*	Rumen
Entodinium simplex	*Capra hircus*	Rumen
Entodinium tricostatum	*Bos indicus*	Stomach
Eodinium lobatum	*Bos indicus*	Stomach
Eodinium bilobosum	*Bos gaurus*	Stomach
Eodinium rectangulatum	*Bos indicus*	Stomach
Diplodinium dentatum	*Bos indicus*	Stomach
Diplodinium ceylonicum	*Bos indicus*	Stomach
Diplodinium monacanthum	*Bos gaurus*	Stomach
Diplodinium diacanthum	*Bos gaurus*	Stomach
Diplodinium triacanthum	*Bos gaurus*	Stomach
Diplodinium tetracanthum	*Bos gaurus*	Stomach
Diplodinium pentacanthum	*Bos gaurus*	Stomach
Diplodinium anisacanthum	*Bos gaurus*	Stomach
	Capra hircus	Rumen
Diplodinium psittaceum	*Bos indicus*	Stomach
Diplodinium consors	*Capra hircus*	Rumen
Diplodinium costatum	*Capra hircus*	Rumen
Diplodinium minor	*Bos gaurus*	Stomach
Diplodinium crista galli	*Capra hircus*	Rumen
Diplodinium flabellum	*Bos indicus*	Stomach
Eremoplastron rostratum	*Bos indicus*	Stomach
	Bos gaurus	Stomach
	Capra hircus	Rumen
Eremoplastron rotundum	*Bos indicus*	Stomach
Eremoplastron bovis	*Bos indicus*	Stomach
Eremoplastron brevispinum	*Bos indicus*	Stomach
	Capra hircus	Rumen
Eremoplastron megalodentatum	*Bos indicus*	Stomach
Eudiplodinium maggii	*Bos indicus*	Stomach
	Bos gaurus	Stomach
	Capra hircus	Rumen
Diploplastron affine	*Capra hircus*	Rumen
Metadinium medium	*Bos indicus*	Stomach
	Bos gaurus	Stomach
	Capra hircus	Rumen
Metadinium rotundatum	*Bos gaurus*	Stomach
Elytroplastron bubali	*Bos indicus*	Stomach
	Capra hircus	Rumen
Ostracodinium clipeolum	*Bos indicus*	Stomach
Ostracodinium gauri	*Bos gaurus*	Stomach
Ostracodinium gracile	*Bos gaurus*	Stomach
	Bos indicus	Stomach
Ostracodinium mammosum	*Bos indicus*	Stomach
Ostracodinium mysorei	*Bos gaurus*	Stomach
Ostracodinium quadrivesiculatum	*Bos indicus*	Stomach
Ostracodinium rugoloricatum	*Bos indicus*	Stomach
Ostracodinium trivesiculatum	*Bos gaurus*	Stomach
	Bos indicus	Stomach
Ostracodinium venustum	*Bos indicus*	Stomach
Epidinium ecaudatum	*Capra hircus*	Rumen
	Tragulus meminna	Stomach

Parasite	Host	Seat
Epidinium caudatum	*Bos gaurus*	Stomach
	Bos indicus	Stomach
	Capra hircus	Rumen
	Tragulus meminna	Stomach
Epidinium bicaudatum	*Bos indicus*	Stomach
	Tragulus meminna	Stomach
Epidinium tricaudatum	*Bos indicus*	Stomach
	Tragulus meminna	Stomach
Epidinium quadricaudatum	*Bos gaurus*	Stomach
	Bos indicus	Stomach
	Tragulus meminna	Stomach
Epidinium parvicaudatum	*Bos gaurus*	Stomach
Epidinium cattanei	*Bos indicus*	Stomach
	Capra hircus	Rumen
Epidinium eberleini	*Bos indicus*	Stomach
Ophryoscolex spinosus	*Bos indicus*	Stomach
Ophryoscolex tricoronatus	*Capra hircus*	Rumen
Polydinium mysoreum	*Elephas indicus*	Cæcum and colon.
Elephantophilus zeta	*Elephas indicus*	Cæcum and colon
Sphærophrya pusilla	*Paramecium caudatum*	Cytoplasm

(ii) *List of Hosts and their Parasites*

Host	Parasite	Seat
MAMMALIA		
Homo sapiens	*Balantidium coli*	Intestine
Macacus rhesus	*Chilodonella rhesus*	Intestine
	Balantidium rhesum	Intestine
Bos indicus	*Isotricha prostoma*	Stomach
	Dasytricha ruminantium	Stomach
	Blepharocorys ventriculi	Stomach
	Entodinium ellipsoideum	Stomach
	Entodinium longinucleatum	Stomach
	Entodinium acutonucleatum	Stomach
	Entodinium rostratum	Stomach
	Entodinium pisciculum	Stomach
	Entodinium biconcavum	Stomach
	Entodinium bifidum	Stomach
	Entodinium acutum	Stomach
	Entodinium aculeatum	Stomach
	Entodinium laterale	Stomach
	Entodinium rectangulatum	Stomach
	Entodinium brevispinum	Stomach
	Entodinium laterospinum	Stomach
	Entodinium nanellum	Stomach
	Entodinium ovoideum	Stomach
	Entodinium rhomboideum	Stomach
	Entodinium bimastus	Stomach
	Entodinium gibberosum	Stomach

Host	Parasite	Seat
Bos indicus	*Entodinium tricostatum*	Stomach
	Entodinium indicum	Stomach
	Eodinium lobatum	Stomach
	Eodinium rectangulatum	Stomach
	Diplodinium dentatum	Stomach
	Diplodinium ceylonicum	Stomach
	Diplodinium psittaceum	Stomach
	Diplodinium flabellum	Stomach
	Eremoplastron rostratum	Stomach
	Eremoplastron rotundum	Stomach
	Eremoplastron bovis	Stomach
	Eremoplastron brevispinum	Stomach
	Eremoplastron megalo dentatum	Stomach
	Eudiplodinium maggii	Stomach
	Metadinium medium	Stomach
	Elytroplastron bubali	Stomach
	Ostrocodinium mammosum	Stomach
	Ostrocodinium gracile	Stomach
	Ostrocodinium trivesiculatum	Stomach
	Ostrocodinium quadrivesiculatum	Stomach.
	Ostrocodinium venustum	Stomach.
	Ostrocodinium clipeolum	Stomach
	Ostrocodinium rugoloricatum	Stomach.
	Epidinium caudatum	Stomach.
	Epidinium bicaudatum	Stomach
	Epidinium tricaudatum	Stomach.
	Epidinium quadricaudatum	Stomach.
	Epidinium cattanei	Stomach.
	Epidinium eberleini	Stomach.
	Ophryoscolex spinosus	Stomach.
Bos gaurus	*Isotricha intestinalis*	Stomach.
	Isotricha prostoma	Stomach.
	Dasytricha ruminantium	Stomach.
	Entodinium curtum	Stomach
	Entodinium longinucleatum	Stomach.
	Entodinium acutonucleatum	Stomach
	Entodinium contractum	Stomach
	Entodinium indicum	Stomach
	Entodinium nanellum	Stomach
	Eodinium bilobosum	Stomach
	Diplodinium monacanthum	Stomach.
	Diplodinium diacanthum	Stomach.
	Diplodinium triacanthum	Stomach.

Host	Parasite	Seat
Bos gaurus	*Diplodinium tetracanthum*	Stomach
	Diplodinium pentacanthum	Stomach
	Diplodinium anisacanthum	Stomach
	Diplodinium minor	Stomach
	Eremoplastron rostratum	Stomach
	Eudiplodinium maggii	Stomach
	Metadinium medium	Stomach
	Metadinium rotundatum	Stomach
	Ostracodinium gauri	Stomach
	Ostracodinium gracile	Stomach
	Ostracodinium mysorei	Stomach
	Ostracodinium trivesiculatum	Stomach
	Epidinium caudatum	Stomach
	Epidinium quadricaudatum	Stomach
	Epidinium parvicaudatum	Stomach
Cattle	*Balantidium coli* var *bovis*	Intestine
Capra hircus	*Isotricha prostoma*	Rumen
	Dasytricha ruminantium	Rumen
	Entodinium bursa	Rumen
	Entodinium dubardi	Rumen
	Entodinium lobospinosum	Rumen
	Entodinium longinucleatum	Rumen
	Entodinium biconcavum	Rumen
	Entodinium elongatum	Rumen
	Entodinium laterale	Rumen
	Entodinium rectangulatum	Rumen
	Entodinium anteronucleatum læve	Rumen
	Entodinium anteronucleatum monolobum	Rumen
	Entodinium anteronucleatum dilobum	Rumen
	Entodinium caudatum	Rumen
	Entodinium chatterjeei	Rumen
	Entodinium ekendræ	Rumen
	Entodinium furca dilobum	Rumen
	Entodinium nanellum	Rumen
	Entodinium ovinum	Rumen
	Entodinium ovoidonucleatum	Rumen
	Entodinium setnai	Rumen
	Entodinium simplex	Rumen

Host	Parasite	Seat
Capra hircus	*Diplodinium anisacanthum*	Rumen
	Diplodinium consors	Rumen
	Diplodinium costatum	Rumen
	Diplodinium crista-galli	Rumen
	Eremoplastron rostratum	Rumen
	Eremoplastron brevispinum	Rumen
	Eudiplodinium maggii	Rumen
	Diploplastron affine	Rumen
	Metadinium medium	Rumen
	Elytroplastron bubali	Rumen
	Epidinium ecaudatum	Rumen
	Epidinium caudatum	Rumen
	Epidinium cattanei	Rumen
	Ophryoscolex tricoronatus	Rumen
Elephas indicus	*Polydinium mysoreum*	Cæcum and colon.
	Elephantophilus zeta	Cæcum and colon
Tragulus meminna	*Entodinum bursa*	Stomach
	Entodinium dubardi	Stomach
	Entodinium ovalis	Stomach
	Epidinium ecaudatum	Stomach
	Epidinium caudatum	Stomach
	Epidinium bicaudatum	Stomach
	Epidinium tricaudatum	Stomach
	Epidinium quadricaudatum	Stomach
REPTILIA		
Nicoria trijuga	*Balantidium testudinis*	Large intestine
AMPHIBIA		
Rana cyanophlyctis	*Opalina coracoidea*	Intestine
	Opalina lata v *cordata*	Intestine
	Opalina ranarum	Intestine and rectum
	Nyctotherus macropharyngeus	Cloaca
	Balantidium gracile	Rectum
	Balantidium helenæ	Intestine
Rana esculenta var *chinensis*	*Cepedea lanceolata*	Rectum
	Opalina ranarum	Rectum
	Balantidium giganteum	Cloaca
	Balantidium rotundum	Small intestine
Rana hexadactyla	*Opalina lata*	Rectum
	Nyctotherus macropharyngeus	Cloaca
	Nyctotherus magnus	Cloaca
	Balantidium gracile	Rectum
Rana limnocharis	*Cepedea longa*	Rectum
	Opalina lata	Intestine and rectum
	Balantidium helenæ	Intestine
	Nyctotherus cordiformis	Intestine
	Nyctotherus macropharyngeus	Intestine

Host	Parasite	Seat
Rana malabarica	*Opalina lata* v *cordata*	Intestine
	Nyctotherus cordiformis	Intestine
Rana tigrina	*Opalina coracoidea*	Rectum
	Opalina ranarum	Intestine and rectum
	Cepedea seychellensis v *angusta*	Intestine and rectum
	Nyctotherus macropharyngeus	Rectum
	Nyctotherus magnus v *malabarica*	Intestine
	Nyctotherus cordiformis	Intestine
	Balantidium duodeni	Duodenum and small intestine
	Balantidium elongatum	Intestine
	Balantidium gracile	Small intestine
	Balantidium helenæ	Rectum and intestine
	Balantidium ranarum	Rectum
	Balantidium sushilii	Intestine
Rhacophorus maculatus	*Cepedea longa*	Intestine
	Cepedea thiagi	Intestine
	Opalina virgula	Rectum
	Nyctotherus papillatus	Intestine and cloaca
Bufo cinereus	*Opalina ranarum*	Rectum
Bufo macrotis	*Cepedea sialkoti*	Rectum
	Nyctotherus reniformis	Rectum
	Balantidium amygdalli	Rectum
Bufo melanostictus	? *Zelleriella macronucleata*	Rectum
	Cepedea metcalfi	Rectum
	Cepedea punjabensis	Rectum
	Cepedea seychellensis v *angusta*	Intestine
	Cepedea subcylindrica	Intestine
	Opalina coracoidea	Rectum
	Opalina plicata	Rectum
	Opalina ranarum	Intestine
	Opalina scalpriformis	Intestine and rectum
	Opalina triangularis	Intestine and rectum
	Opalina virgula	Intestine
	Nyctotherus cordiformis	Intestine and cloaca
	Nyctotherus papillatus	Cloaca
	Balantidium bicavata	Rectum
Bufo variabilis	*Opalina ranarum*	Rectum
MOLLUSCA		
Ampullaria globosa	*Nyctotherus kempi*	Rectum
	Balantidium depressum	Rectum
Lamellidens marginalis	*Conchopthirius curtus*	Mantle chamber
	Conchopthirius lamellidens	Mantle chamber
	Conchopthirius elongatus	Mantle chamber

Host	Parasite	Seat
Small gastropods	*Anoplophrya elongata*	Rectum
	Anoplophrya variabilis	Intestine
Viviipara bengalensis	*Anoplophrya cylindrica*	Intestinal canal
ARTHROPODA		
Calotermes militaris	*Nyctotherus termitis*	Intestine
Culicoides peregrinus	*Balantidium knowlesii*	Cœlom
Periplaneta americana	*Nyctotherus ovalis*	Mid-gut and hind-gut
	Balantidium blattarum	Intestine
	Balantidium ovatum	Intestine
ANNELIDA		
Ælosoma chlorostictum	*Anoplophrya ælosomata*	Alimentary canal
Pheretima hawayana	*Maupasella nova*	Alimentary canal
Pheretima posthuma	*Anoplophrya lloydi*	Seminal vesicles
	Maupasella nova	Alimentary canal
	Parabursaria pheretima	Seminal vesicles
PROTOZOA		
Paramecium caudatum	*Sphærophrya pusilla*	Cytoplasm

Technique.

Methods for the examination and study of PROTOZOA are adequately dealt with in such works as Prowazek and Jollos (1921), Wenyon (1926), Hartmann (1928), Bělař (1928), and Gatenby and Cowdry (1928) The principal methods followed in the study of the CILIOPHORA are given here for the benefit of those taking up the study of the group

Examination in the Living Condition —It is desirable to make observations on the living animals in the first instance The specimens are mostly studied in a drop of the natural medium in which they are found, either under a small cover-slip or as hanging drop preparations In such preparations the general features of the anatomy of the organism can be better interpreted than in the dead and preserved animal It is also possible to observe the animal from different sides For that purpose the cover-slip is carefully removed with the help of a needle, and through the addition or abstraction of water the necessary pressure on the organism is regulated One has to be careful in these manipulations, especially if the organism is rather rare or only few specimens are available If the water under the cover-slip begins to evaporate, even partially, the pressure of the cover-slip becomes sufficient to injure the general form or some particular part, and the animal is rendered unfit for further study In some cases the protoplasm flows out and the organisms are quickly destroyed, in others the protoplasm does not flow out, but the animals are killed outright by the gentlest pressure applied to them

As a rule a preliminary examination of a sample of water should be carried out with the aid of a centrifuge on the day the collection is made. With a speed of 2,000 revolutions per minute almost all the Ciliates in a sample are collected at the bottom of the tube in about thirty seconds, so that it is necessary to examine only 1 centimetre of water, which can be drawn from the bottom of the tube by means of a pipette. This is rather important if a complete census of the forms inhabiting a particular sample of water is to be made, as very often some of the less hardy organisms die off during the night, especially under the conditions of temperature and atmosphere in a laboratory.

If the observations have to be interrupted (as, for example, under the exigencies of class work) it is best to surround the cover-slip with a ring of wax or vaseline, or transfer the slide to a moist chamber. A jar with a tight-fitting stopper and with some wet blotting-paper placed inside it serves as a simple but effective moist chamber, in which the slides can be kept and observations made from day to day. The organisms will live and continue to multiply in such a chamber provided they are supplied with their proper food. In many cases the drop of water containing the organisms may also contain a certain amount of silt or earthy matter, and the animal cannot be satisfactorily studied unless this is removed. For this purpose a noose of cotton-thread or a loop of fine wire can be used. This is introduced into the drop of water on a slide, and by pulling away the noose with the earthy particles the drop very often may be rendered clear, with the organism swimming freely in it and no longer able to hide itself among the earthy particles.

Parasitic Ciliates should be examined in the fluid in which they naturally occur. The contents of the alimentary canal of an animal may usually be diluted with ordinary physiological saline solution (0.75 per cent. sodium chloride in distilled water).

Slowing the Movements.—The various methods for slowing the movements of rapidly-moving forms, and thus making possible their study in the living condition, are fully described by Statkewitsch (1905). For workers in India I (1920) suggest the use of the mucilage obtained by soaking *Ispaghul* seeds (seeds of *Plantago ovata*). This can be readily obtained in varying degrees of consistency, and has the further advantage of being perfectly transparent. It can be added directly to the drop of water containing the Ciliates on the slide, or, better still, the seeds may be spread at the bottom of a tube in a layer about 1–2 cm. thick, and the culture containing the Ciliates poured on to them to the height of 8–10 cm.,

when in a day or two, by the diffusion of the mucilage into the culture, a proper consistency is obtained If a drop is now examined under the microscope the Ciliates will be found to be moving hardly at all, yet without showing any change in body-form or in the character of the ciliary movement of the organism *Paramecia* and certain other Ciliates show a positive chemotactic reaction towards this mucilage, and in a culture that has been standing over the seeds for twenty-four hours they will be found in large numbers just at the junction of the culture fluid and the layer of seeds

If the culture is allowed to stand in contact with the *Ispaghul* seeds for two days or a longer period, the colouring matter of the seeds also diffuses out into the culture, and the organisms are thereby stained *intra vitam* a beautiful brick-red colour

The exact position and character of the cytostome and the character and arrangement of the cilia are often difficult to determine in the living organism For the former a little Indian ink or finely powdered carmine particles is run under the cover-slip, and for the latter the preparation may be irrigated with a drop or two of a 1 per cent solution of alum This latter treatment renders the cilia very distinct but often kills the organism, so it should be applied only after other observations have been completed on the living creature For studying the stalk and the axial filament of Vorticellids the addition of a drop or two of 10 per cent alcohol gives the best results *Stentor* is best observed in an extended condition by mounting the specimen on a slide, covering it with a cover-glass, and leaving it overnight in a moist chamber

Intra-vitam Staining—Examination of the living organisms is facilitated by *intra-vitam* staining different parts of the organism or the contents of the vacuoles are thus coloured without killing the animal or affecting its movements For this purpose "neutral red" in very dilute solution (1 in 10,000) may be employed, and it is necessary to add only a very small quantity of the stain to the fluid containing the organisms Neutral red assumes a bright cherry-red colour in acid and a brown colour in alkaline media, and thus serves to indicate the reaction of the substances which it stains

As mentioned above, *Ispaghul* seeds, when added to the water containing the Ciliates, will serve to slow their movements as well as to stain them

Cultivation—Cultures of PROTOZOA have been classified by Williams as being of three types —

(1) *Mixed Cultures*—Those that contain the "*omnium*

gatherum" of pond or tap water, a heterogeneous mixture of protozoan, bacterial and fungoid organisms mixed with lower metazoan forms, such as rotifers, crustaceans, and so forth

(2) *Pure Mixed Cultures*—These involve the cultivation of one species of PROTOZOA in association with a pure strain of one other micro-organism, such as a bacterium or some other protozoon

(3) *Pure Cultures*—These are cultures of PROTOZOA grown in a medium that contains no other organism

If care is taken to keep up the proper food-supply and to make up for loss of water by evaporation by the addition of more water, it is often possible to keep cultures in good condition for several weeks For pure mixed cultures a decoction of dry leaves is prepared and sterilized The sterilized medium is then filtered into corked tubes, and a single individual of the species it is desired to cultivate is isolated under the microscope and transferred to the culture medium As the tubes are not sterilized, and are only half filled with the medium, one or more strains of bacteria soon make their appearance in the culture, and the Ciliate thrives quite well in association with them

For the cultivation of *Paramecia* and some other freshwater Ciliates the following methods are usually recommended, the object being in every case to develop a bacterial flora which will be suitable for the Ciliate it is desired to cultivate —

(1) Fill to ¼ height a small glass tumbler with boiled water, and suspend in it by means of a thread a linen or muslin bag containing previously boiled salad-leaves, and keep the glass covered with a glass plate

(2) A solution of 0 0125 or 0 025 per cent of Liebig's meat extract may be employed as a culture medium In the stronger solution bacterial growth is stronger, and the culture must be renewed after eight to ten days In weaker solutions the culture can continue for about six weeks

(3) Obtain a 6-inch by 8-inch battery jar and fill it with pure distilled water to a depth of 5 or 6 inches Add 30 or 40 grains of boiled wheat After several days a heavy bacterial scum will develop on the surface of the water Two days after the scum appears inoculate by adding *Paramecia* from another culture *Paramecia* will feed on the bacteria and reproduce very rapidly They will clear up the culture in a few

days and will remain in good condition for some time A new culture should be started about once every month

Barret and Yarbrough (1921) reported the successful culture of *Balantidium coli* for over thirty-two days, during which time eleven subcultures were made Schumaker (1931) has also successfully cultivated the Ciliate on a medium consisting of 1 0 c c of sterile horse serum and 9 0 c c of sterile Ringer's solution, following the technique of Rees (1927) and of Jameson (1927) Various methods for the culture of special organisms are discussed by Bělař (1928)

Fixation and Staining—Of the reagents commonly employed the following may be used for fixing (1) concentrated solution of corrosive sublimate, hot or cold, (2) Schaudinn's sublimate alcohol (2 parts saturated aqueous solution of corrosive sublimate, 1 part absolute alcohol, immediately before use, add acetic acid to the quantity to be used to the strength of 5 per cent), (3) Bouin's fluid (saturated aqueous solution of picric acid 75 parts, formol 25 parts, and acetic acid 5 parts), (4) Zenker's fluid (mercuric chloride 5 grms, potassium bichromate 2 5 grms, sodium sulphate 1 grm in 100 c.c. of distilled water, with 2 5 to 5 per cent of glacial acetic acid added just before use), (5) formalin, and (6) vapour of 4 per cent solution of osmic acid

Mass Method—If the Ciliates are abundantly present the mass method is used for staining them The fluid containing the PROTOZOA is put in a centrifuge tube and fixative (twice the quantity of the fluid containing the PROTOZOA) added, and the two well shaken together The fixative is allowed to act, and, after centrifuging, the bulk of the fluid is poured off and the washing fluid (alcohol or water as the case may be) poured on After again centrifuging this is poured off, and the process repeated until the fixative is completely removed Then the organisms are stained and dehydrated according to any of the usual methods (such as the borax-carmine method or Delafield's hæmatoxylin method), centrifuging after each stage Then clear in clove-oil and mount in Canada balsam, for this purpose pure clove-oil is put in the bottom of the tube and absolute alcohol gently poured over it, so that the two fluids may not mix With a pipette the material to be cleared is added and allowed to sink down through the media When it has passed through the pure clove-oil and reached the bottom of the tube it will be cleared and ready for mounting

Centrifuged PROTOZOA, especially the parasitic forms, tend to stick together in masses after fixation These can be treated like bits of tissue, embedded in paraffin and cut into sections

Staining under the Cover-slip —For staining large organisms, when not abundantly present, the following method is used —

Wax feet are put at the corners of a square cover-slip, which is inverted over a drop of water containing the organisms The wax feet should hold the cover-slip firmly to the slide With a pipette a little fixative is run under one side of the cover-slip, and drawn through by holding a piece of filter-paper at the opposite side When the fixative has had time to act it is washed out by substituting another fluid (alcohol or water as the case may be) and drawing this through with filter-paper in the same manner The stream should not be so violent as to wash away the organisms, but the substitution should be complete The stain is then run under, allowed to act, and washed out and differentiated if necessary, the process being controlled under the microscope The specimen is dehydrated and then cleared in clove-oil or xylol, and a very fluid Canada balsam is run under It is very important to see that the transfer from one fluid to another is not too rapid, as otherwise there is great risk of shrinkage, and also that the dehydration is complete

The following is an indication of the length of time generally required, but should be regarded as no more than an indication Fix in Bouin's fluid, 5 mins , wash in 70 per cent alcohol, 5 mins (several changes), stain in borax-carmine, 5 mins or more , differentiate in acid-alcohol, 5 mins or more , dehydrate with 70 per cent , 90 per cent and absolute alcohol, 5 mins each, changing the absolute alcohol once or twice , clear by running in a mixture of clove-oil and absolute alcohol, and then pure clove-oil , mount in Canada balsam by running the same under the cover-slip

Staining the Organisms fixed on a Cover-slip —Another method, specially serviceable in the staining of parasitic organisms, is either to make a number of smears of the fluid containing the organism on cover-slips, and when the fluid has partially dried to invert the cover-slips and let them float on the surface of the fixative contained in a dish, or to put a small drop of water containing the organism on a cover-slip and add with a pipette twice the quantity of hot fixative When the organisms are fixed on the cover-slips these are passed successively through the washing fluid, alcohols, stain, clearing fluid, etc , all these reagents being contained in shallow dishes In all these subsequent stages the cover-slip is put at the bottom of the fluid in the dish, with the face bearing the organisms upward Finally, the cover-slips are removed and put, face downward, on slides on each of which a drop of Canada balsam has been put In this way quite a large number

of smears or preparations can be fixed and stained in practically the same time as would be taken to make one preparation

Staining Methods.—The following stains are usually employed for staining the PROTOZOA —

Borax-carmine.—Fix in Bouin's fluid for 10 to 20 minutes according to bulk and permeability Wash out in 70 per cent alcohol (several changes) Stain in borax-carmine till thoroughly penetrated, 15 minutes are usually enough for small objects Differentiate in acid alcohol, controlling under the microscope Dehydrate, 90 per cent to absolute alcohol Put in clove-oil and absolute alcohol, equal parts. After a few minutes transfer to pure clove-oil, and leave there till cleared Mount in Canada balsam

Delafield's Hæmatoxylin.—This is suitable for staining PROTOZOA in smears or for staining in mass Fix in Schaudinn's fluid Wash in 30 per cent alcohol, and bring down through 10 per cent alcohol to distilled water Add a few drops of Delafield's hæmatoxylin solution to a watch-glass full of distilled water Leave in stain for a few minutes to an hour or more, according to bulk If overstained, wash out excess of colour with alcohol containing 1 per cent nitric or hydrochloric acid The material should be brought up from distilled water gradually to 70 per cent alcohol in which there is a trace of acid Dehydrate, clear, mount

Heidenhain's Iron Hæmatoxylin.—Fix in Schaudinn's fluid for 10 to 30 minutes, according to size and permeability of the object Bring down through 30 per cent and 10 per cent. alcohol to distilled water The fixative must be thoroughly washed out Mordant in 4 per cent. aqueous solution of iron alum for ½ hour to 12 hours according to size of organism Wash for a second or two in water Stain in Heidenhain's aqueous hæmatoxylin solution (about 0 5 per cent) for 30 minutes to several hours Wash in water Differentiate in 1 per cent iron alum solution Control under microscope Wash in running water for at least half an hour Bring through alcohols to absolute alcohol Clear in xylol Mount in Canada balsam

Dobell's Iron Hæmatein.—Fix in Schaudinn's fluid Bring down through 30 per cent and 10 per cent alcohol to distilled water After washing bring up through various grades of alcohol to 70 per cent, and from that transfer to 1 per cent solution of iron alum in 70 per cent alcohol for 10 minutes, (The solution is made by dissolving 1 grm iron alum in 23 c c. warm distilled water and adding 77 c c of 90 per cent alcohol) Rinse in 70 per cent alcohol Stain in 1 per cent solution of hæmatein in 70 per cent alcohol for 10 minutes. Rinse

in 70 per cent alcohol Differentiate films in original iron alum solution, and sections in 70 per cent acid alcohol Wash in several changes of 70 per cent alcohol Dehydrate, clear, mount The whole process may be carried out in 30 minutes Light green in 90 per cent alcohol may be used as a counter-stain

Hæmalum and Picro-carmine—A drop containing the organisms is spread on a cover-slip, and before the preparation is dried the cover-slip is inverted over hot corrosive sublimate solution contained in a watch-glass The animals will thus be fixed and will stick to the cover-slip Then transfer the cover-slip for 2 minutes to iodine alcohol, 15 to 30 minutes in 70 per cent alcohol, 15 minutes in weaker alcohols, to water Stain for 5 minutes in dilute hæmalum solution (equal parts of stain and water), keep for 3 minutes in water (till no more colour comes off), and pass the preparation through ascending grades of alcohol (5 to 10 minutes in each), or, after staining and washing off excess of hæmalum, stain in picro-carmine (2 to 3 minutes), wash in water (till no more colour comes off), and then pass through ascending grades of alcohol to absolute alcohol Clear in xylol (5 minutes), and invert the cover-slip over a slide on which a drop of Canada balsam has been put

In simple staining the nuclei are seen with dark-blue stained chromatin on a clear blue ground, in double staining on red ground.

Instead of hæmalum alum-carmine can be used, but not in conjunction with picro-carmine

Mallory's Eosin and Methylene Blue—This is recommended for sections fixed in Zenker's fluid Wash out the fixative in running water for several hours Stain in warm 5 per cent aqueous solution of eosin for 20 minutes or longer, wash in water, and stain in Unna's alkaline methylene-blue solution, diluted with 4 to 5 parts of water, for 10 to 15 minutes Wash in water, differentiate in 95 per cent alcohol, controlling under a microscope, until sections are pinkish, but nuclei deep blue Dehydrate quickly and mount

Mallory's Triple Stain—This is recommended for sections of tissues containing parasites Fix in Zenker's fluid Thoroughly wash out the fixative for several hours in gently running water Stain sections in 0 5 per cent aqueous solution of acid fuchsin for 2 to 4 minutes, and transfer to the second solution (consisting of aniline blue soluble in water (Grubler) 0 5 grm., Orange G (Grubler) 2 0 grm, 1 per cent aqueous solution of phosphomolybdic acid 100 c c) for 10 to 20 minutes or longer Wash and differentiate the sections in tap-water, dehydrate rapidly, clear, and mount.

Sharp (1914) employed a slightly modified method for demonstrating the neuromotor system in Ciliates Lund (1933) recommends Zenker's fluid with 2 5 per cent acetic acid, staining the sections for 2 minutes in Mallory No I, and 1 minute in No II, then dipping rapidly into 95 per cent and absolute alcohol, blotting quickly between each change, and then clearing in xylol for about 3 minutes

Silver Impregnation Methods—Both the dry silver method of Klein (1926) and the wet silver method of Gelei and Horváth (1931) depend on the reduction of silver nitrate by sunlight depositing colloidal silver on certain structures, which are thus rendered visible

(a) *Klein's Dry Silver Method*—Air-dry the smear Put the slide in 2 per cent silver nitrate solution in the dark for 15 to 20 minutes Rinse in distilled water and expose the slide to diffuse sunlight, from time to time watching under the microscope till the ciliary lines are well shown Finally, dip the slide in a very weak solution of hyposulphite of soda (one or two crystals in 100 c c of distilled water) for a very short period (one or two dips will do) Dry the smear again and mount in Canada balsam

(b) *Gelei and Horváth's Wet Silver Method*—The following procedure is suggested by Lund (1933) —Concentrate the Ciliates by centrifuging Fix for 3 minutes in a mixture of 95 c c concentrated aqueous solution of mercuric chloride and 5 c c formalin Wash twice in filtered river-water Impregnate for 3 minutes in 2 per cent solution of silver nitrate Without washing, reduce in distilled water by direct sunlight for 8 minutes Wash five times in distilled water Dehydrate slowly Pass through absolute alcohol, clear in xylol, and mount in Canada balsam

Bresslau's Method of Staining with Opal Blue—This gives very pretty preparations showing the arrangement of the cilia and other superficial structures Centrifuge the Ciliates, and put a drop of water or culture fluid containing a large number of organisms on a perfectly clean slide Place close to it a similar-sized drop of a colloidal anilin blue stain known as opal blue Mix the two drops and spread out into a film either by a needle or a second clean slide, rapidly dry the films by swinging in the air, and mount in Canada balsam

Grubler's ready-made solution of cyanochin (3 parts of China blue and 1 part of cyanosin in concentrated watery solution) can be employed in the same way as opal blue

Gelei's Osmium-Toluidin blue Method—Very instructive preparations of pellicular structure and ciliary arrangement are obtained by this method Fix for 1 to 12 hours in a

mixture of 10 parts of 2 per cent osmium-tetraoxide solution and 1 part of formol (as the mixture rapidly deteriorates, it should be prepared immediately before use, and fixation carried on inside an iron cupboard) or in osmic and acetic acid mixture After fixing in formol-osmium do not wash, but put immediately for 1 to 12 hours in potassium-bichromate-alum solution (potassium bichromate 2 grms , potash alum 1 grm , distilled water 100 c c), then wash for a short time in distilled water and keep for 1 to 12 hours in ammonium molybdate solution After washing again in distilled water, stain for 2 to 4 minutes in a 0 3 to 0 1 per cent watery solution of toluidin blue Then quickly dehydrate and mount in Canada balsam Cilia, basal granules and many other pellicular structures are stained deep blue, while cytoplasm and nucleus are left uncoloured

Phylum PROTOZOA.

Subphylum CILIOPHORA.

The subphylum CILIOPHORA is divided into two classes, as follows —

1 Provided with cilia throughout life, ingestion through a cytostome or by osmosis [p 49. **Ciliata** Butsch,

2 Cilia present only in the young free swimming embryos budded off from the adult Adult provided with sucking-tubes or tentacles which serve for ingestion [p 423. **Suctoria** Bütsch,

Class I CILIATA Butschli

The main features of the organisms belonging to this class have been outlined in the chapter dealing with the general organization and structure The class CILIATA is distinguished from the class SUCTORIA by the cilia, covering the body, being present throughout life, and by ingestion taking place through a definite cytostome or through osmosis over the general surface of the body

The class is divided into two subclasses, PROTOCILIATA and EUCILIATA, as follows —

1 Parasitic forms, without a cytostome, uniformly ciliated, and possessing either two or many nuclei, the nuclei not being differentiated into two kinds [p 50. **Protociliata** Metcalf,

2 Freshwater or parasitic forms, the majority possessing a cytostome, some without a cytostome, ciliation entire or confined to various parts of the body, nuclear apparatus showing a differentiation into a macronucleus and a micronucleus [p 72 **Euciliata** Metcalf

I. Subclass *PROTOCILIATA* Metcalf

Parasitic forms, generally found in the alimentary canal of Amphibia. Body oval or elongated, cylindrical or flattened, and covered with a uniform covering of cilia, arranged in longitudinal rows. Cytostome absent, liquid food being absorbed over the whole surface. Contractile vacuole absent; a non-contractile excretory canal present in a few species. Two or many nuclei present, not showing any differentiation. The nuclei are vesicular. Each nucleus contains, besides a nucleolus, a number of large massive chromosomes or macrochromosomes and small granular chromosomes or microchromosomes. In the ectoplasm there are numerous spherules known as cytomicrosomes, and somewhat similar but smaller granules in the endoplasm are known as endoplasm spherules. Multiplication takes place by binary fission, mitotic division of the nuclei being followed by an oblique longitudinal splitting of the organism. Repeated divisions in multinucleate forms give rise to small individuals with a small number of nuclei. These become encysted and are passed out into the water by their hosts. Tadpoles ingest these cysts and the Ciliates are set free in the rectum. In the spring, by repeated divisions, minute uninucleate individuals are formed, which are differentiated as microgametes and macrogametes. These conjugate in pairs, and the resulting zygotes by continued multiplication of the nucleus become the adult multinucleate organisms.

Metcalf (1918, 1923) has separated the Opalinids from the other Ciliates in a separate subclass PROTOCILIATA. "The Opalinidæ are an offshoot from the primitive Ciliata before the latter had acquired true binuclearity and the subsequent dimorphism of nuclei." Hartog (1906) and Neresheimer (1907 *b*) placed the Opalinids among the Flagellates, but Minchin (1912), Doflein (1916), and other writers have included them with the astomatous Ciliates. Cépède (1910) clearly showed that the Opalinids are not closely related to other astomatous Ciliates, and Metcalf, as the result of his extensive studies on this group, separated them from the other astomatous Ciliates and placed them in a separate subclass, in order to give expression to their primitive character. Gatenby and King (1925) have, however, again revived the claim that *Opalina* should be classified among the Flagellates, since its motile organs are flagellar in nature. Their claim rests

on their observation that, as in Flagellates, "the 'cilia' enter right into the substance of the organism, and take their origin from the peculiar granules which exist in very large numbers in the protoplasm of *Opalina*" (as shown in their figure) As against this observation we have the statement of Metcalf that the kinetoplasm is in the form of basal granules of the cilia, and that a network of neural fibrillæ connects these In *Protoopalina intestinalis* the axial fibre of each cilium arises from a spherical basal granule which lies just beneath the pellicle Bezzenberger (1904) described basal granules elongated perpendicularly to the pellicle in *Cepedea longa* Metcalf found spherical basal granules in *C longa* Bhatia and Gulati (1927) found that in *Cepedea metcalfi* the basal granules of the cilia, which are extremely fine, and situated just beneath the pellicle, are not connected with the endospherules that are situated deeper in the protoplasm, and the same was also the case in *Opalina coracoidea* and *Opalina ranarum*

The subclass includes a single family

Family OPALINIDÆ Claus.

Metcalf has divided the family into two subfamilies, as follows —

[Metc, p 51

1 Cylindrical or flattened binucleate forms PROTOOPALININÆ

2 Cylindrical or flattened multinucleate forms OPALININÆ Metc, [p 53

Subfamily PROTOOPALININÆ Metcalf, 1923

Opalinids with cylindrical or flattened body and possessing only two nuclei

No members of this subfamily, which includes the genera *Protoopalina* and *Zelleriella*, have been found in India This is in accord with the previous findings of Metcalf *Z macronucleata* has been reported by Bezzenberger in *Bufo melanostictus* from "Asia" The presence of a *Zelleriella* in a south-eastern Asian toad is so strange that Metcalf questions the Asiatic origin of the host He considers the possibility of confusion of labels or of the host in question having become infected from some South American Anuran Metcalf opened thirty-nine specimens of this toad without finding *Zelleriella*, and Bhatia and Gulati (1927) have also examined a number of specimens of *Bufo melanostictus*, but did not find any *Zelleriella* in them

Genus **ZELLERIELLA** Metcalf, 1923

Zelleriella, Metcalf, 1923, p 85

Much flattened binucleate Opalinids Nuclei large, about 10 μ in greatest diameter, with few macrochromosomes, 4 to 10 so far observed Microchromosomes equal or about equal in number to the macrochromosomes

1 **Zelleriella macronucleata** (Bezzenberger). (Fig 1)

Opalina macronucleata, Bezzenberger, 1904, pp 163–5, figs 14, 15
Zelleriella macronucleata, Metcalf, 1923, pp 117–9, figs 82, 83

Form ovoidal Nucleus spherical, diameter of resting nucleus 12 μ Cilia uniform, close, length of cilia 4 μ

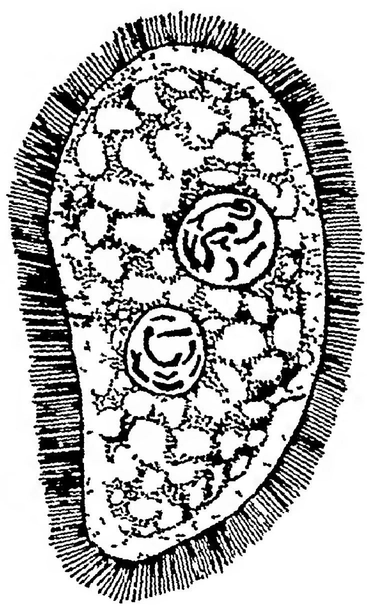


Fig 1 —*Zelleriella macronucleata* (Bezz) (After Bezzenberger)

Dimensions —Length 63 μ, width 40 μ, thickness of body 30 μ

Remarks —The chromatin in the spherical, resting nucleus is in the form of two or three large plaques at the surface of the nucleus, while the rest of the nuclear contents show a finely reticulate structure Bezzenberger has figured stages of mitosis in daughter organisms

Habitat —Rectum of *Bufo melanostictus* Schneider Asia (exact locality not cited by Bezzenberger) Metcalf has expressed doubt as regards the assigning of this *Zelleriella* to *Bufo melanostictus* from Asia "

Subfamily OPALININÆ Metcalf, 1923

Opalinids with cylindrical or flattened body and possessing many nuclei

This subfamily is well represented in Indian frogs and toads

Key to Indian Genera

1	Form cylindrical, circular in cross section	CEPEDEA Metc , p 53
2	Form flattened, ellipsoidal in cross section	OPALINA Purk & Val , [p 60

Genus **CEPEDEA** Metcalf, 1923

Cepedea, Metcalf, 1920, p 136 , 1923, p 137 , Wenyon, 1926, p 1153 , Calkins, 1926, p 401 , Bhatia & Gulati, 1927, p 89 , Reichenow, 1929, p 1164

Multinucleate Opalinids that are circular or nearly so in cross-section, or at least not uniformly flattened throughout the body

The genus *Cepedea* is cosmopolitan, except that it is at present not known from Australasia or north-eastern North America Discussing the geographical distribution of the species of this genus Metcalf comes to the conclusion that its place of origin was probably India or some portion of the India–Ceylon–Madagascar–Africa bridge " Two-thirds of the known species of *Cepedea* are from the Eastern Hemisphere, a fact which is some indication that the genus arose in the east This seems the more true, since we have so scant data from Southern Asia Probably the list of eastern species would be considerably increased if we knew the southern Asian forms " (Metcalf, 1923, p 336) Again, on p 345 of his work Metcalf observes, " It is unfortunate that Indian Anura have been so little explored for Opalinids, for thorough knowledge of southern Asian Opalinids might give light upon the presence of a member of this group of Cepedeas in the Seychelles "

Bhatia and Gulati (1927) examined only *Bufo melanostictus* from Lahore and *Bufo macrotis* from Sialkot in the Punjab, and found three new species of *Cepedea*, two in the first and one in the second host No species of this genus were found to occur in the three species of *Rana*, viz , *R tigrina*, *R cyanophlyctis* and *R hexadactyla*

Key to Indian Species

1 (3)	With a pointed spine like projection at the anterior end	2
2	Body triangular in cross section Posterior end bluntly rounded Length 82 μ	*C punjabensis* Bh & G, [p 57
3 (1)	Anterior end without a spine like projection	4
4 (5)	Body greatly elongated, anterior end rounded, posterior tapering to a point Length 200–1000 μ	*C longa* Bezz , p 55
5 (4)	Body not greatly elongated	6
6 (9)	Body cylindrical	7
7 (8)	Sides of the body curved Anterior end rounded, posterior pointed Length 71–108 μ	*C metcalfi* Bh & G , [p 56
8 (7)	Sides of the body straight Anterior end presenting a vacuolated appearance, posterior end rounded or some times pointed Length 125–440 μ	*C thiagi* de Mello, [p 60
9 (6)	Body ovoid or fusiform	10
10 (11)	Body ovoid, anterior end broad and rounded, posterior end slender and tapering Nuclei only four or five Length 82 μ	*C lanceolata* Bezz , [p 54
11 (10)	Body fusiform	12
12 (13)	Body subcylindrical, both ends rounded or anterior end less pointed than the posterior Length 35–250 μ	*C subcylindrica* [de Mello, p 60
13 (12)	Both ends pointed	14
14 (15)	Posterior end drawn out into a sharp point Length 64–89 μ	*C sialkoti* Bh & G [p 58
15 (14)	Posterior end not drawn out into a sharp point Length 51–218 μ	*C seychellensis angusta* [de Mello, p 58

2 **Cepedea lanceolata** (Bezzenberger) (Fig 2)

Opalina lanceolata, Bezzenberger, 1904, pp 165–6, pl xi, fig 7
Cepedea lanceolata, Metcalf, 1923, pp 137–8, figs 102, 103

Body ovoid, with anterior end rounded and posterior end elongated into a slender tapering point Nuclei large, irregularly spherical , generally four, rarely five in number, lying one behind the other in an axial row , diameter of nucleus 7 μ Cilia fine and close , length of cilia 2 μ

Dimensions —Length 82 μ, width of body 22 μ

Remarks —The nuclei are quite large and the number of macrochromosomes quite small for a *Cepedea* Metcalf thinks that in the size of its nuclei and the number of its macrochromosomes *C lanceolata* is more like the Protoopalinas than are other Cepedeas, and may well be a transitional species between the two genera

Habitat —Rectum of *Rana esculenta* Linn var *chinensis* Osborn Asia (exact locality not cited by Bezzenberger)

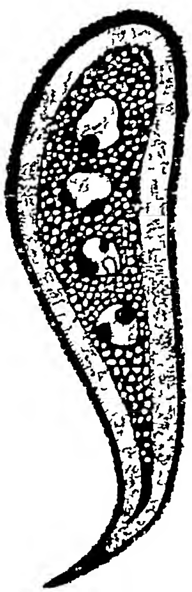
3. Cepedea longa (Bezzenberger) (Fig. 3.)

Opalina longa, Bezzenberger, 1904, pp. 167–8, pl. xi, fig 11, text-figs 18–20
Cepedea longa, Metcalf, 1923, pp 168–70, fig 137
†*Cepedea longa*, de Mello, 1930, p 955, figs 14–24, 1931 *a*, p 1184, 1931 *b*, pp 1443–5, pl xxxviii, figs 14–24

Body greatly elongated, rounded in front and tapering posteriorly to a rounded point, anterior end flattened, body

Fig 3

Fig 2



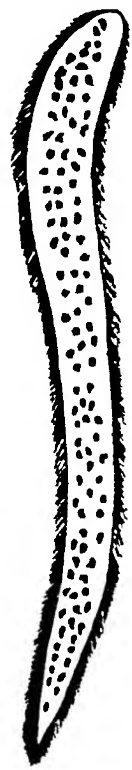


Fig 2 —*Cepedea lanceolata* (Bezz) (After Bezzenberger)
Fig 3 —*Cepedea longa* (Bezz) (After de Mello)

broadly elliptical in cross-section. Endoplasm with a thick central zone of closely compact alveoli, contrasting strongly with a thin and loose peripheral zone Nuclei spherical or ellipsoidal, with a diameter of 4 5–7μ Cilia of moderate length

† prefixed to a reference indicates that the record of the species from India Burma or Ceylon is based on this reference

Dimensions—Length 200–1000 μ, usually 450–575 μ, width 52–75 μ

Remarks—Bezzenberger describes the basal granules of cilia as very slender elongated rods, which is exceptional for Opalinids Metcalf finds that his specimens are larger, have more elongated and smaller nuclei, and the basal granules of cilia are spherical or nearly so

Habitat—Rectum of *Rana limnocharis* Wiegmann Asia (exact locality not cited by Bezzenberger) Intestine of *Rhacophorus maculatus* NOVA GOA

4 **Cepedea metcalfi** Bhatia & Gulati (Fig 4)

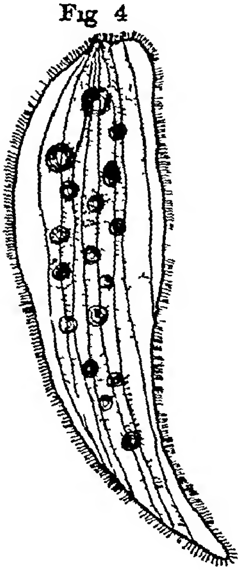
†*Cepedea metcalfi*, Bhatia & Gulati, 1927, pp 89–91, fig 1

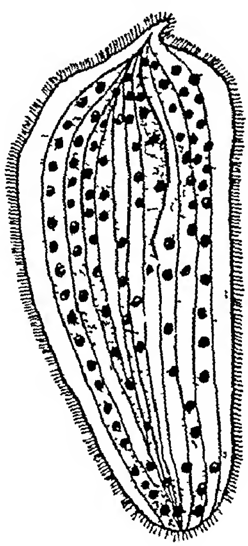
Body form varies much in smaller and bigger forms, but intergrades are present Contour of the body not a straight

Fig 5

Fig 4

Fig 6





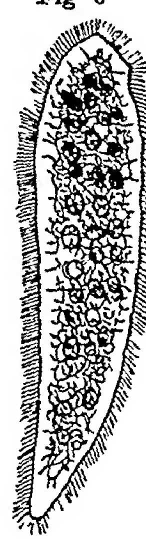


Fig 4—*Cepedea metcalfi* Bh & G (After Bhatia and Gulati)
Fig 5—*Cepedea punjabensis* Bh & G (After Bhatia and Gulati)
Fig 6—*Cepedea seychellensis* var *angusta* de Mello (After de Mello)

cylinder, but the sides are curving in and out slightly Anterior end rounded, posterior drawn to a point In smaller individuals body pointed at both ends, but posterior end much

narrower and tapering Ciliation fine and close Nuclei many and rounded in form

Dimensions —Length from 71–108μ

Remarks —The pellicle is a fairly thick membrane and exhibits longitudinal grooves running somewhat spirally These grooves are demonstrable with difficulty, and the ciliary rows are set in them The outer layer of ectoplasm is homogeneous and does not show any alveoli, reticulations or granules The basal granules of the cilia are extremely fine, lie in this outer layer just beneath the pellicle, and are so close set as to make the pellicle appear a thick membrane under the lower powers of the microscope The basal granules are united by extremely fine threads both longitudinally and transversely The internal layer of the ectoplasm has an alveolar structure, the alveoli being bigger than those of the endoplasm There are no ectoplasm spherules in this layer The endop asm is alveolar and the alveoli are smaller than those of the inner layer of the ectoplasm Besides the numerous large, rounded nuclei in this region, there are other spherules of a smaller size which are more deeply staining Each of these latter has an outer thick wall bounding a clear area The endoplasm is also dotted over with innumerable darkly-staining granules, which may be described as "cytomicrosomes" The cilia are small, fine and close set, and are arranged in longitudinal rows running parallel to the margin of the body

Even the biggest examples of this species are smaller than the small specimens of *Cepedea pulchra javensis* There are many rounded nuclei In the resting nucleus the nuclear membrane is of appreciable thickness Chromatin may be in the form of a single big mass or several smaller masses connected by threads, and a number of rod-like masses lying just within the nuclear membrane When dividing, the nucleus elongates, a constriction appears in the middle and deepens till the two halves are practically separated The nuclear membrane does not disappear in the process, and for a time the two daughter nuclei remain connected by a thread-like portion derived from the nuclear membrane

Habitat —Rectum of *Bufo melanostictus* Schneider PUNJAB, Lahore

5 **Cepedea punjabensis** Bhatia & Gulati (Fig 5)

†*Cepedea punjabensis*, Bhatia & Gulati, 1927, pp 91–2, fig 2

Form oval, with a sharply pointed spine-like projection at the anterior end Body pulled out along three planes so as

to appear triangular in cross-section Greatest width in front of the middle of the body, narrower posteriorly Posterior end bluntly rounded Ciliation fine and close Nuclei many and rounded

Dimensions —Length about 82 μ

Remarks —The layer of ectoplasm is thinner than in *C metcalfi*, but is well marked off from the endoplasm, which has an alveolar appearance There are a large number of rounded nuclei Also contained in the endoplasm in great abundance are darkly-staining spherules and minute granules The cilia are fine and close-set The basal granules are hardly visible Over the general surface of the body the cilia are arranged in longitudinal rows

This species has some resemblance to *C pulchra javensis* in its general form, but the specimens are smaller than those of *C pulchra* or its subspecies, and the form is not considerably flattened as in that species

Habitat —Rectum of *Bufo melanostictus* Schneider PUNJAB, Lahore

6 **Cepedea seychellensis** var **angusta** de Mello (Fig 6)

†*Cepedea seychellensis* var *angusta*, de Mello, 1932, pp 96–7, pl xii, fig 15, pp 105, 124, pl xiii, fig 5

Form regularly fusiform, with the posterior pole drawn out Body consisting of a peripheral zone of loose alveoli and a central zone of small and closely crowded meshes, with numerous rounded nuclei irregularly dispersed in it Diameter of nuclei 3–3 5 μ

Dimensions —Minimum 50 μ by 21 μ, maximum 218 μ by 39 μ, usually between 86–175 μ in length

Remarks —The dimensions of the form encountered in *Rana tigrina* are smaller than those found in *Bufo melanostictus* and quoted above The eighty-two individuals measured by de Mello were mostly between 75–110 μ in length

Habitat —Intestine of *Bufo melanostictus* Schneider and *Rana tigrina* Daud NOVA GOA

7 **Cepedea sialkoti** Bhatia & Gulati (Fig 7)

†*Cepedea sialkoti*, Bhatia & Gulati, 1927, pp 92–3, fig 3

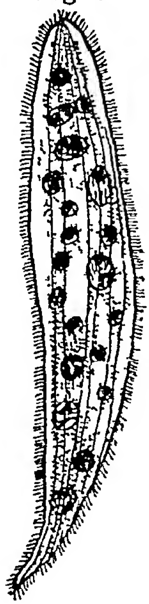
Body has an oval, cylindrical form, pointed at both ends, posterior end tapering to a point Greatest width of the body in front of the middle Ciliation fine and close Nuclei numerous, rounded or oval

Dimensions —Length 64–89 μ

Remarks —The structureless region below the pellicle is hardly defined The inner layer of the ectoplasm also is not well differentiated The endoplasm has a granular appearance The bigger specimens contain fewer nuclei than the smaller

Fig 9

Fig 7



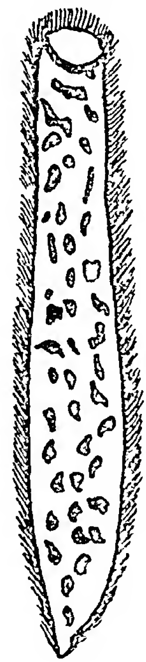


Fig 8

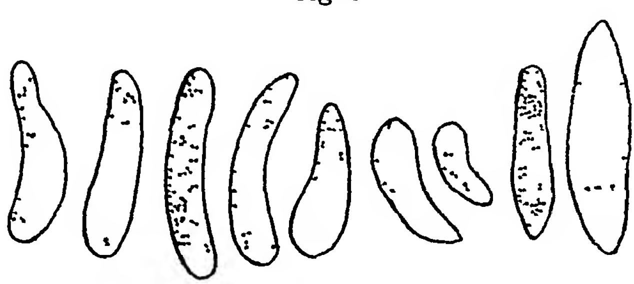


Fig 7 —*Cepedea sialkoti* Bh & G (After Bhatia and Gulati)
Fig 8 —*Cepedea subcylindrica* de Mello Cilia not shown in the figure (After de Mello)
Fig 9 —*Cepedea thiagi* de Mello (After de Mello)

ones The nuclei vary in size The nuclei showing division seem to be drawn out into two points, with the chromatin gathered at the poles The cilia are fine and close-set and

are arranged in longitudinal rows on the surface of the body Basal granules are not distinguishable

Habitat—Rectum of *Bufo macrotis* Boulenger PUNJAB, Sialkot

8 **Cepedea subcylindrica** de Mello (Fig 8)

†*Cepedea subcylindrica*, de Mello, 1932, pp 93–5, 120, 124, pl xii, fig 13

†*Opalina subcylindrica*, de Mello, 1932, pl xii, fig 13

Form elongated, fusiform, the anterior pole in general less pointed than the posterior pole Many variations from this form have been seen, the anterior pole in some examples being blunt and rounded and the posterior pole having sometimes the same disposition, so that the organism looks like a regular cylinder Diameter of the nucleus 2 5–3 5 μ

Dimensions—Minimum 35 μ by 15 μ, maximum 250 μ by 80 μ, usually between 80–185 μ in length

Habitat—Intestine of *Bufo melanostictus* Schneid NOVA GOA

9 **Cepedea thiagi** de Mello (Fig 9)

†*Cepedea thiagi*, de Mello, 1930, pp 955–6, figs 25–31, 1931 *a* p 1184, 1931 *b*, p 1445, pl xxxviii, figs 25–31

Form cylindrical, with the posterior pole rounded or sometimes pointed, anterior pole with alveoli loosely arranged in such a manner as to present a single vacuole surrounded by a compact zone Numerous nuclei, 4–5 μ in diameter

Dimensions—Length, minimum 125 μ, maximum 440 μ

Habitat—Intestine of *Rhacophorus maculatus* Gray NOVA GOA

Genus **OPALINA** Purkinje & Valentin, 1835, emend Metcalf, 1923

Opalina, Purkinje & Valentin, 1835, p 43, Englemann, 1876, p 574, Zeller, 1877, p 352, Hickson, 1901, p 404, Metcalf, 1909, pp 195–375, pls xiv–xxviii, Minchin, 1912, pp 439, 452–4, Metcalf, 1920, p 136, 1923, p 175, Hegner & Taliaferro, 1924, pp 383, 410, Wenyon, 1926, p 1153, Calkins, 1926, pp 374–5, 401, Reichenow, 1929, pp 1164–5, Thomson & Robertson, 1929, p 276

Multinucleate Opalinids with uniformly and much flattened body

According to Metcalf two subgeneric groups, not sharply marked off from each other, can be recognized, namely, the *obtrigona*-like species, *Opalinæ angustæ*, which are in general oblanceolate in form, and *ranarum*-like species, *Opalinæ latæ*, which are more rounded

Key to Indian Species

1 (12)	More or less rounded in form	2
2 (5)	Posterior end of the body with a pointed spur	3
3 (4)	Form ovoid, asymmetrical	*O coracoidea* Bezz, [p 61
4 (3)	Form oval, broader, and with a proportionately longer and more curved posterior beak	*O coracoidea lahoriensis* Bh & G, p 62
5 (2)	Posterior end of the body broadly rounded	6
6 (11)	Anterior end of the body distinctly narrower than the posterior end Width always greater than half the length	7
7 (10)	Form oval	8
8 (9)	Central medullary zone does not show the alveoli crowded together in longitudinal columns	*O lata* Bezz, p 64
9 (8)	Central medullary zone shows the alveoli crowded together in longitudinal columns	*O lata cordata* de Mello, [p 65
10 (7)	Form ovate Dorsal surface with two or four ridges	*O plicata* Ghosh, p 65
11 (6)	Anterior end only slightly narrower than the posterior end Width less than half the length up to two thirds the length	*O ranarum* (Ehrbg), [p 66
12 (1)	Body oblanceolate in form	13
13 (14)	Form strongly curved, with long, slender, rod like endospherules	*O virgula* Dobell, [p 70
14 (13)	Form not strongly curved, without rod-like endospherules Anterior portion of the body thrown into a number of folds or ridges	15
15 (16)	Body about 4 to 5 times as long as broad	*O scalpriformis* Ghosh, [p 68
16 (15)	Body about twice as long as broad	*O triangularis* Ghosh, [p 68

10 **Opalina coracoidea** Bezzenberger (Fig 10)

Opalina coracoidea, Bezzenberger, 1904, p 166, pl xi, figs 8, 9, Metcalf, 1923, pp 234–5, fig 209
†*Opalina coracoidea*, de Mello, 1932, pp 118–9, pl xiv, fig 4

Form very flattened, ovoid, asymetrical Posterior pole in the form of a pointed spur Numerous nuclei about 3 5μ in diameter

Dimensions—204μ by 120μ (Bezz) 82–136μ by 45–81μ (de Mello)

Remarks—De Mello in his examples found the nuclei to be elliptical and measuring 4–5μ by 3 88–4 5μ

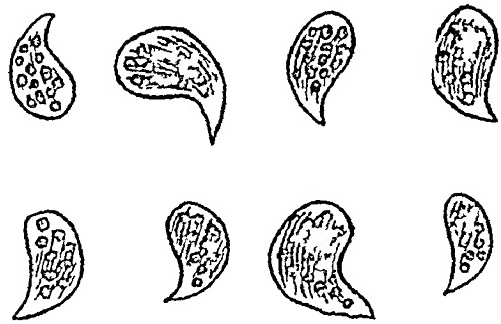


Fig 10 —*Opalina coracoidea* Bezz Cilia not shown in the figures (After de Mello)

Habitat —Intestine of *Rana cyanophlyctis* Schneid NOVA GOA

11 **Opalina coracoidea** subsp **lahoriensis** Bhatia & Gulati (Fig 11)

Opalina coracoidea, Bezzenberger, 1904, p 166, pl xi, figs 8 9
Opalina coracoidea, Metcalf, 1923, pp 234–5, fig 209
†*Opalina coracoidea lahoriensis*, Bhatia & Gulati, 1927, pp 93–6, fig 4

Form oval, about $1\frac{1}{2}$ to $2\frac{1}{2}$ times as long as broad, with sharply pointed posterior end bent to one side Broader and with a proportionately longer and more curved posterior beak than in the typical species The greatest width is usually near the posterior end, but some individuals are broadest in the anterior half of the body

Dimensions —Length 117–231μ, width 48–148μ

Remarks —Bezzenberger (1904) described *Opalina coracoidea* from *Rana cyanophlyctis* from "Asia " Metcalf was not able to get any material of this species Bhatia and Gulati (1927) recorded the species from two new hosts, viz , *Rana tigrina* and *Bufo melanostictus* *Opalina coracoidea* is abundantly found in *Rana tigrina*, and may be regarded as the commonest Opalinid in this host

The characteristic feature of *O coracoidea* is that the posterior end of the body is sharply pointed and beaked, the beak being bent to one side *O japonica* also shows a beaked end, but the beak is much less developed The specimens found by Bhatia and Gulati were broad, with a proportionately longer and curved beak In the outline of the body, measurements of length and breadth, and dimensions of the beak their specimens differed markedly from the typical form of *O coracoidea* Bezz , and on account of these differences they described

it as a new subspecies, they have given a full description of its structure and life-history

The usual layers of the body, viz, the pellicle, the outer ectoplasm, the inner ectoplasm, and the endoplasm are recognizable, but the ectoplasm is not so thick as indicated by Bezzenberger for *O coracoidea* The cilia arise from spherical basal granules situated just beneath the pellicle and connected with each other by fine fibres The cilia are long and fine and arranged in longitudinal rows There is a large number of nuclei Each resting nucleus contains four large chromatin masses just inside the nuclear membrane and one or more karyosomes

Fig 11

Fig 12

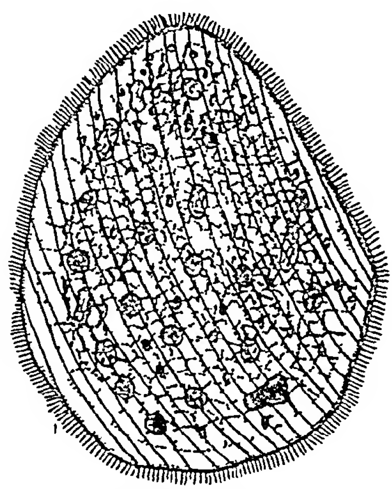


Fig 11 —*Opalina coracoidea lahoriensis* Bh & G (After Bhatia and Gulati)
Fig 12 —*Opalina lata* Bezz (After Bhatia and Gulati)

lying in the centre Smaller chromatin particles are also present at the nodes of the achromatin network The mitosis is of the usual type The chromatin resolves into a number of chromosomes which arrange themselves in a linear manner on the spindle-fibres A constriction finally appears in the middle of the elongated nucleus, and the daughter nuclei separate Besides the nuclei there are many spherical or elongate oval masses called endospherules in the endoplasm, and other much more minute, darkly-staining granules, known as cytomicrosomes, are found abundantly

The full-grown individuals divide by longitudinal or oblique fission, but the beaked end is always involved in such a division The two daughter Opalinas, after separation, exhibit for

a time a broad anterior end, and are narrowed and drawn out posteriorly into a fine tail, which appears to be a simple continuation of the body, but as the individuals grow in size the tail-end assumes a beak-shaped appearance

By rapid and repeated divisions smaller individuals, each with only two or three nuclei, result These become encysted, and such infection cysts, passing out with the fæces, are readily devoured by other tadpoles or frogs Cysts were found in the stomach and duodenum of a frog On the cyst-wall being dissolved minute individuals screw themselves out These individuals possess two or more nuclei and a number of chromidial masses lying close to them Having escaped from the cysts they divide into as many parts as there are nuclei, and thus form uninucleate gametes The gametes in this species are nearly similar In conjugation they are seen to approach each other either by their tail or by their anterior ends, lie parallel to one another, and then fuse Copulation cysts were not found, and development of zygotes into full-sized Opalinas was not followed

Habitat—Rectum of *Rana tigrina* Daud and *Bufo melanostictus* Schneider PUNJAB, Lahore

12 **Opalina lata** Bezzenberger (Fig 12)

Opalina lata, Bezzenberger, 1904, pp 166–7, pl xi, fig 10 Metcalf, 1923, p 238, fig 213
†*Opalina lata*, Bhatia & Gulati, 1927, pp 97–8, fig 6
†*Opalina lata*, de Mello, 1932, pp 117

Form oval, anterior end narrower, posterior broadly rounded Rows of cilia extraordinarily close together Nuclei very numerous

Dimensions—Length of body 260–300 μ, width 180–224 μ

Remarks—The anterior half of the body is more or less triangular The greatest width is about the middle of the body Some specimens of *O ranarum* approach this species in form, but the relative proportion of the length of the body to the breadth is never 2 1, as it is in *O ranarum* In *O lata* the breadth is always greater than half the length, and is very nearly equal to it in some examples Bezzenberger gives 0 3 mm as length and 0 18 mm as breadth, but specimens found at Lahore were usually shorter and broader De Mello gives 60 μ by 40 μ as the minimum and 160 μ by 80 μ as the maximum dimensions, usually the length of his specimens being between 120–140 μ His specimens were thus markedly smaller than is generally the case for the species The rows of cilia are extraordinarily close together and the cilia are very close-set in the rows The nuclei are very numerous and smaller than those of *O ranarum*

Habitat—Rectum of *Rana limnocharis* Wiegmann and *R hexadactyla* Lesson Asia (exact locality not cited by Bezzenberger), *R hexadactyla* Lesson PUNJAB, Lahore, intestine of *Rana limnocharis* Wiegman NOVA GOA

13 **Opalina lata** var. **cordata** de Mello (Fig 13)

†*Opalina lata* var *cordata*, de Mello, 1932, pp 114–16, 118, pl xiv, figs 2, 3, & 6

Form oval, with the anterior end narrower and posterior end broader and rounded Width usually greater than half the length Body shows a fine membrane, a cortical zone, and a central medullary zone formed of alveoli closely crowded together The disposition of these alveoli in longitudinal columns or bundles is characteristic of the variety, bands

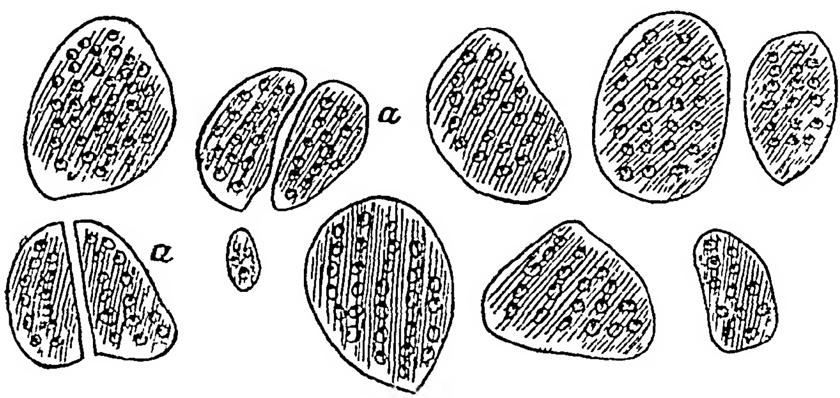


Fig 13—*Opalina lata* var *cordata* de Mello *a*, dividing forms Cilia not shown in the figures (After de Mello)

of closely crowded alveoli alternating with bands of loose and colourless alveoli Nuclei rounded or oval, generally elliptical, diameter of nuclei 2–5 μ

Dimensions—Minimum 30 μ by 20 μ (young forms), maximum 340 μ by 170 μ, usually between 150–245 μ in length

Habitat—Intestine of *Rana malabarica* Tsch and *R cyanophlyctis* Schneid NOVA GOA

14 **Opalina plicata** Ghosh (Fig 14)

†*Opalina plicata*, Ghosh, 1919 *b*, p 102, figs 3, 4, 1921, p 6

Body broadly or elongately ovate (slightly longer than broad), tapering and rounded anteriorly, wide and rounded posteriorly

Dorsal surface with two or four ridges, two of which are nearly parallel and extend from near the anterior end down to each side posteriorly, sometimes in broader forms two ridges of one side may be absent Numerous nuclei

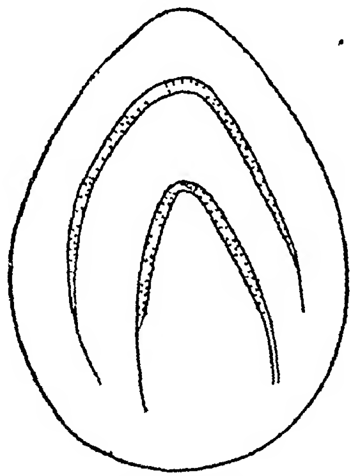


Fig 14 —*Opalina plicata* Ghosh
Cilia not shown in the figure (After Ghosh)

Habitat—Intestine and rectum of *Bufo melanostictus* Schneid Calcutta

15 **Opalina ranarum** (Ehrenberg) (Fig 15)

Bursaria ranarum, Ehrenberg, 1831, p 110, 1835, p 164, 1838, p 330, pl xxxv, fig 7
Opalina ranarum, Purkinje & Valentin, 1835, pp 43, 59, Dujardin, 1841, pp 462, 463, pl xiii, fig 13, Claparède & Lachmann, 1858–61, p 374, Stein, 1859 *b*, p 37, 1867, pp 10–11, 24
Bursaria ranarum, Ray Lankester, 1870, p 148, pl ix, fig 9
Opalina ranarum, Engelmann, 1876, pp 574–7, pl xxi, figs 1–15, Zeller, 1877, pp 353–65, pl xxiii, figs 1–26, Kent, 1880–2, pp 559–60, pl xxvi, figs 1–9, 20, pl xxxi, fig 19, Bütschli, 1887–9, pp 1718–19, pl lxv, fig 8, *a–h*, Schewiakoff, 1896, p 393, pl vi, fig 153 Loewenthal, 1904, pp 387–90, figs 1–10, 1909, pp 115–20, 1 fig, Metcalf, 1923, pp 222–4, figs 197–8, King & Gatenby, 1926, pp 217–19, pl xxi, Wenyon, 1926, pp 1154–7, figs 488–9
†*Opalina ranarum*, Bhatia & Gulati, 1927, p 96, fig 5
Opalina ranarum, Reichenow, 1929, pp 1159–65, figs 1145–6, 1148–51
†*Opalina ranarum*, de Mello, 1932, pp 98–100, 124, pl xii, fig 17, pp 103–5, pl xiii, fig 4, p 118, pl xiv, fig 5

Form variable, generally oval, anterior end being a little narrower than the posterior, which is broadly rounded Length of the body one and a half to three times the width

Dimensions—Minimum 80μ by 27μ, maximum 299μ by 105μ, usually between 120–190μ in length, diameter of nucleus 3μ

Remarks—Both *O ranarum* and *O coracoidea* are usually found inhabiting the rectum of *Rana cyanophlyctis* Generally in these infections there are a few specimens of *O coracoidea* along with a very much larger number of *O ranarum*

The ectoplasm is thick The pellicle and the basal granules from which the cilia arise are distinctly seen The anterior edge of the body is specially thickened The cilia are fine

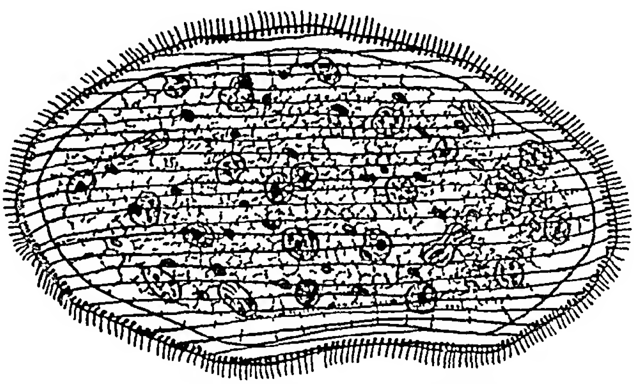


Fig 15—*Opalina ranarum* (Ehrbg) (After Bhatia & Gulati)

and close-set and arranged in longitudinal rows The ciliary lines run in continuous spirals on the two surfaces of the flattened body

The endoplasm has the usual structure The nuclei are numerous They all show one or more massive clumps of chromatin lying within the nuclear membrane These masses are seen to be connected by fine chromatin fibres forming a network The nuclei and the endospherules are specially crowded together in the anterior region of the body

Habitat—Rectum of *Rana esculenta*, *Bufo cinereus*, and *Bufo variabilis* Asia (exact locality not cited by Bezzenberger), rectum of *Rana cyanophlyctis* Schneider Punjab, Lahore, intestine of *Rana tigrina* Daud, *R cyanophlyctis* Schneider, and *Bufo melanostictus* Schneid Nova Goa

16 Opalina scalpriformis Ghosh (Fig 16)

†*Opalina scalpriformis*, Ghosh, 1919 *b*, p 103, fig 5, 1920 *b*, pp 78–84 2 pls, 1921 *a*, p 6
Opalina obtrigonoidea forma *plicata*, Metcalf, 1923, p 185, fig 154
†*Opalina scalpriformis*, de Mello, 1932, pp 97–8, pl xii, fig 16
†*Opalina obtrigonoidea* forma *plicata*, de Mello, 1932, pp 123–4

Body elongated cylindrical, anteriorly rounded, posteriorly narrower Anterior portion of the body thrown into a variable number of longitudinal folds or ridges

Dimensions—Minimum 97 μ by 23 μ, maximum 350 μ by 75 μ, usually between 140 μ and 275 μ in length Diameter of nuclei 3–3 5 μ

Remarks—Ghosh (1919) described *O scalpriformis* as a new species, with the following brief description, and later (1920) described its cytology more fully —" Body elongated, about

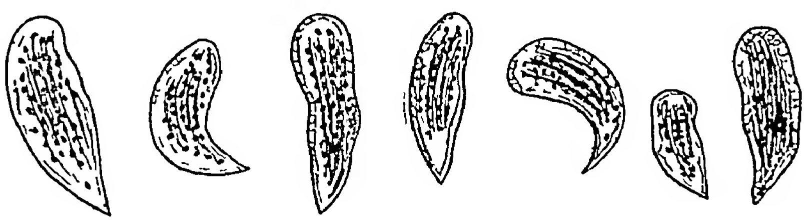


Fig 16—*Opalina scalpriformis* Ghosh Cilia not shown in the figures (After de Mello)

4 to 5 times as long as broad, being flattened at the anterior end with a truncate edge, four sided (in transverse section) in the anterior half or so, and cylindrical and slightly tapering to a blunt point posteriorly, the four ridges in the anterior portion of the body run in a slightly spiral curve posteriorly, so that the animal appears twisted round the long axis, numerous nuclei" De Mello (1932) has studied the form more fully, and has given the measurements and figures of a number of individuals He identifies it with *O obtrigonoidea* forma *plicata* Metcalf, 1923

Habitat—Intestine and rectum of *Bufo melanostictus* Schneid BENGAL, Calcutta, intestine of *Bufo melanostictus* Schneid NOVA GOA

17 Opalina triangularis Ghosh (Fig 17)

†*Opalina triangularis*, Ghosh, 1919 *b*, p 102, figs 1, 2, 1921 *a*, p 6
Opalina obtrigonoidea, Metcalf, 1923, pp 177–85, figs 143–53
†*Opalina triangularis*, de Mello, 1932, pp 95–6, pl xii, fig 14
†*Opalina obtrigonoidea*, de Mello, 1932, pp 122–4

Body oblanceolate, more or less rounded and widest anteriorly, narrow and tapering posteriorly, one margin of the

body convex, the other concave Differentiated from *O obtrigona* by its greater diversity in form, not only between different infections, but between different individuals in a single infection, and by the small size of its nuclei Diameter of nuclei, 3–4 μ

Dimensions —Minimum 85 μ by 40 μ, maximum 390 μ by 175 μ, usually between 150 and 300 μ in length

Remarks —Ghosh (1919 *b*) described *O triangularis* as a new species, giving a brief description, which is quoted below, as it is published in a journal which is not easily obtainable — "Body flattened, leaf-like, twice as long as broad or less,

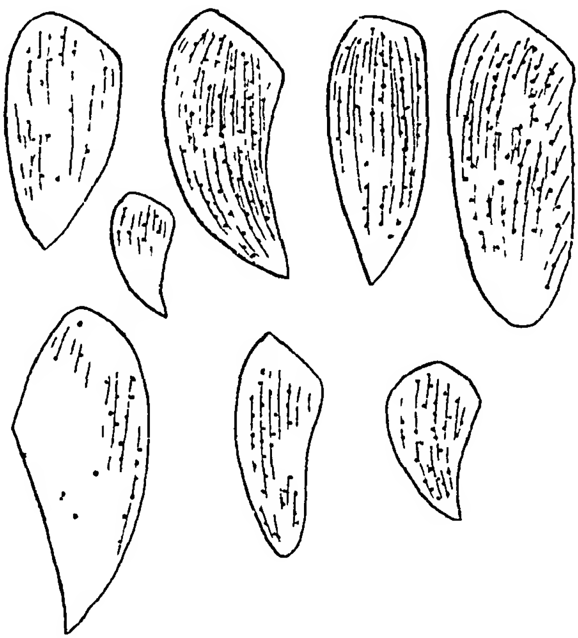


Fig 17 —*Opalina triangularis* Ghosh Cilia not shown in the figures (After de Mello)

widest in the anterior body-half , one side nearly straight, and other strongly convex, giving the appearance of two curved sides meeting at the widest part of the body , anterior end rounded and in the same line with the straight side , posterior end tapering and rounded , numerous nuclei " De Mello (1932) has studied the same form more fully, and given the measurements and figures of a large number of individuals After identifying his form with *O triangularis* Ghosh, he has later come to the conclusion that both his form and that met with by Ghosh belong to the same species as *O obtrigonoidea*

Metcalf, 1923 The name *O triangularis* Ghosh must be given priority over *O obtrigonoidea* Metcalf described many varieties, and *O triangularis* shows the closest resemblance with the one described from *Rana pipiens* (Metcalf, 1923. fig 150, *c*)

Habitat—Intestine and rectum of *Bufo melanostictus* Schneid BENGAL, Calcutta , intestine of *Bufo melanostictus* Schneid NOVA GOA

18 **Opalina virgula** Dobell (Fig 18)

†*Opalina virgula*, Dobell, 1910, p 76, pl ii, fig 17
Opalina virgula, Metcalf, 1923, pp 202–3, fig 171
†*Opalina virgula*, de Mello, 1930, pp 952–5, figs 1–13 , 1931 *a*, p 1184 , 1931 *b*, pp 1442–3, pl xxxviii, figs 1–13 , 1932, pp 92–3, pl xii, fig 12

Body-form strongly curved, long and slender or broader and shorter, with the greatest width in the anterior half

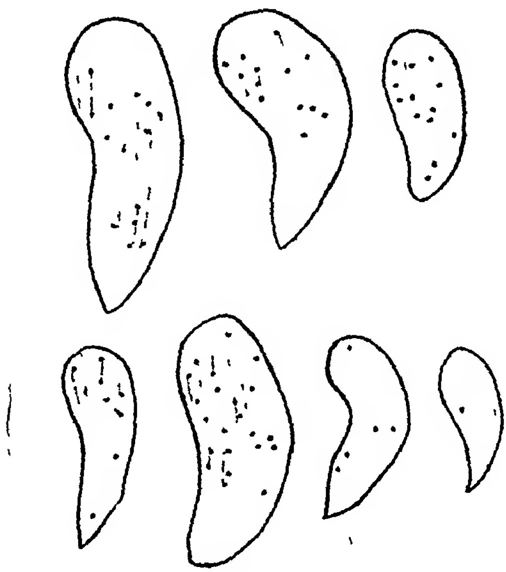


Fig 18 —*Opalina virgula* Dobell Cilia not shown in the figures (After de Mello)

posterior end always narrower and rounded Nuclei many, large, spherical , diameter of nucleus 4 5–5 5μ Cytoplasm with large number of elongated, slender endospherules, which lie with their long axes transverse to the length of the body and parallel to its surface Cilia fine, close, and moderately long

Dimensions—Length of body 38–380 μ, usually between 100–200 μ, width 13–85 μ, at the broadest part of the anterior portion

Remarks—Metcalf considers the occurrence of *O virgula* in *Polypedates* (?) *maculatus* from Ceylon as a most surprising occurrence which needs careful scrutiny With the exception of *Opalina virgula*, the Ceylonese form, the *virgula*-like species are so similar to *obtrigona*-like species, both in structure and distribution, that they may be treated together as one group *O virgula* is demarcated by its long, slender, rod-like, endoplasmic plastids Metcalf is inclined to believe that it should be regarded as distinct in origin from the other *Opalinæ angustæ*, and that it probably arose independently from some *Cepedea*

Habitat—Rectum of *Polypedates* (*Rhacophorus*) *maculatus* (Gray) CEYLON, Peradeniya , NOVA GOA , intestine of *Bufo melanostictus* Schneid NOVA GOA

II Subclass *EUCILIATA* Metcalf.

The subclass Euciliata includes Ciliates which show the characteristic nuclear dimorphism, a macronucleus and a micronucleus being always present

The shape of the body varies considerably it may be ovoid, elongate, dorso-ventrally flattened, or bell-shaped The forms are free-swimming or attached by means of a stalk The majority of them possess a mouth or cytostome followed by an œsophagus or cytopharynx leading into the endoplasm Very often the cytostome is situated at the end of a groove or depression known as the peristome The cilia are uniformly distributed over the body or are restricted to particular areas By fusion of adjacent cilia either stout processes, known as cirri, or membranes may be formed In a large number of forms special adoral cilia are arranged in a spiral manner in front of the cytostome and are continued into the cytopharynx as cilia or as membranes In one group of parasitic Ciliates the cytostome is absent

The subclass is divided into the following four orders —

1	Body uniformly covered with cilia, or cilia limited to certain areas No adoral zone of spirally arranged cilia	**Holotricha, p 73**
2	Peristome provided with an adoral zone of spirally arranged cilia	3
3 (6)	From its starting point at the anterior end of the body the adoral zone turns to the right	4
4 (5)	Entire body, or at least the ventral surface, covered with cilia	**Spirotricha, p 209**
5 (4)	Entire body not covered with cilia Adoral zone not formed of distinct membranelles	**Chonotricha, p 422**
6 (3)	From its starting point at the anterior end of the body the adoral zone turns to the left , Body not covered by cilia except for a posterior ciliary wreath, which may be temporarily or permanently present	**Peritricha, p 393**

I Order HOLOTRICHA Stein.

The order HOLOTRICHA includes forms in which the body is uniformly covered with cilia arranged in longitudinal rows, or the cilia may be restricted to certain areas Cytostome usually present (absent only in ASTOMATA), and may be terminal, subterminal, or somewhere on the ventral surface or the right side Cytostome may be a simple opening leading to a tubular cytopharynx, not provided with special cilia or membranes (GYMNOSTOMATA), or the cytopharynx may be provided with free cilia (TRICHOSTOMATA) or with membranes (HYMENOSTOMATA) Some forms bear a contractile proboscis Spines and caudal filaments are present in some forms Nutrition is holozoic, or parasitic (in ASTOMATA) Reproduction by transverse fission Encystment common Found in fresh water, brackish water, or, less commonly, in sea water Some forms are parasitic

Identification Table of Suborders

1	(6 or 9)	Cytostome present	2
2	(3)	Cytostome kept closed except at the moment of ingestion, not provided with cilia or membranes, cytopharynx simple or supported by a rod apparatus, peristome usually absent	[p 74 **Gymnostomata,**
3	(2)	Cytostome permanently open, provided with cilia or membranes ; cytopharynx, if present, bearing cilia or membranes, peristome usually present, not parasitic in Molluscs and not strikingly thigmotactic	4
4	(5)	Oral groove provided with more or less thickly situated rows of free cilia	[p 137 **Trichostomata,**
5	(4)	Oral groove provided with membranes formed by the fusion of one or more rows of cilia, and also with fine cilia	[p 162 **Hymenostomata,**
6	(1 or 9)	Cytostome present or rudimentary or even absent, parasitic on Molluscs, etc, or *commensals on other* Ciliophora, strikingly thigmotactic	7
7	(8)	Strikingly thigmotactic, with a ciliated area specially differentiated for attachment to a substratum, usually found in the branchial cavities of mussels, a few forms ectoparasitic on Vorticellids and Suctoria	[p 193 **Thigmotricha,**

8	(7) With complicated life history and change of hosts, alternately on the body of Crustacea or in Cœlenterates, a few forms endo parasitic in Cephalopoda and Heteropoda	**Apostomea,** p 198
9 (1 or 6)	Cytostome absent	**Astomata,** p 199

1 Suborder *GYMNOSTOMATA* Butschli

HOLOTRICHA with body not always entirely covered with cilia Cilia may be confined to one side of the body or limited to widely separated spiral rows Cytostome lies on the surface of the body—that is, it is not sunken, and no peristomial groove leads to it It is kept closed except at the moment of ingestion, and is not provided with cilia or membranes It may be round or slit-like and situated at the anterior pole (PROSTOMATA), or shifted back so as to lie along one border (PLEUROSTOMATA), or lie on the ventral surface (HYPOSTOMATA) Cytopharynx is tubular, simple or provided with rod-apparatus consisting of trichites

In some forms the body is covered with a tightly fitting armour of plates Pseudopodia are present in some forms in addition to cilia

The genera of GYMNOSTOMATA are classified into fourteen families, which are placed in three tribes, as follows —

(1) Cytostome at the anterior pole or its immediate neighbourhood	**Prostomata,** p 74
(2) Cytostome slit like, running from the anterior pole along the compressed ventral border or rounded and situated at the base of a proboscis	**Pleurostomata,** [p 105
(3) Cytostome in the anterior half of the flattened ventral surface	**Hypostomata,** p 124

1. Tribe **PROSTOMATA** Schewiakoff, 1896.

Gymnostomatous Ciliates with the cytostome at the anterior pole of the body or close to it

Identification Table of the Families.

1	(2) Cytostome slit like, surrounded by a prominent, laterally compressed, padded margin provided with trichocysts	**Spathidiidæ** Kahl, [p 101
2	(1) Cytostome round with or without padded margins	3

3	(4)	Cytostome borne on a receptacle situated on the anterior part of the body, test-dwelling	**Metacystidæ** * Kahl
4	(3)	Cytostome without receptacle, not test dwelling	5
5	(6)	Cytostome at the summit of an apical truncated cone, which is surrounded at its base by a ciliary girdle, with one or more additional ciliary girdles, rest of the body uniformly ciliated or naked	**Didiniidæ** Poche, [p 93
6	(5)	Cytostome at the anterior end	7
7	(8)	Body covered with a lorica of regularly arranged plates	**Colepidæ** Clap & [Lachm , p 96
8	(7)	Surface of the body otherwise	9
9	(10)	Body with radially arranged, stiff, retractile pseudopodia	**Actinobolinidæ** * [Kent
10	(9)	Body without pseudopodia	11
11	(12)	Body uniformly ciliated	**Holophryidæ** Perty, [p 75
12	(11)	Long cilia densely covering entire anterior end, cilia over rest of the body may be absent, parasitic	**Butschliidæ** Poche, [p 103

1. Family HOLOPHRYIDÆ Perty, 1852

Body spherical or ellipsoidal, with cilia uniformly arranged in longitudinal rows, not covered with a lorica and not provided with retractile pseudopodia Cytostome round, situated at the anterior end, not provided with any special appendages Cytopharynx almost always provided with trichocysts or trichites

Key to Indian Genera

1	(8)	Body egg shaped or flask-shaped, never with an oral cone which is provided posteriorly with a wreath of longer cilia	2
2	(3)	Posterior end of the body with one or more setæ	UROTHRICHA Clap & [Lachm , p 80
3	(2)	Posterior end of the body without setæ	4
4	(7)	Body not drawn out into a neck	5
5	(6)	Cytopharynx absent or tubular, with at the most weakly developed rods	HOLOPHRYA Ehrbg , [p 76
6	(5)	Cytopharynx conical, with distinct rods or fine longitudinal striations	PRORODON Ehrbg , [p 81
7	(4)	Anterior end drawn out	ENCHELIS Müll , [p 90
8	(1)	Body elongate, worm-like or flask-shaped, may be provided with an oral cone, at the posterior end of which is a circle of longer cilia	9

* Indicates that no representative of the family has been recorded from India so far

9 (10)	With an annular furrow near anterior end, marking off an apical portion provided with spiral rows of cilia	[p 85 LACRYMARIA Ehrbg,
10 (9)	Without an annular furrow marking off an apical portion	11
11 (12)	Anterior region not narrowed, no spiral stripes	[Ehrbg, p 92 TRACHELOCERCA
12 (11)	Anterior region narrowed, with longitudinal or slightly spiral stripes	[p 92 CHÆNEA Quenn,

Genus **HOLOPHRYA** Ehrenberg, 1831

Holophrya, Ehrenberg, 1831, p 101, 1838, p 314, Claparède & Lachmann, 1858–61, p 312, Fromentel, 1874, p 188, Kent, 1880–82, p 498, Schewiakoff, 1889, p 10, 1896, p 118, Roux, 1901, p 20, Penard, 1922, p 13, Calkins, 1926, p 404, Lepsi, 1926 *a*, p 34, Schoenichen, 1927, p 177, Sandon, 1927, p 171, Reichenow, 1929, p 1168, Kahl, 1930–5, p 47

Animalcules free-swimming, body regularly ellipsoidal to cylindrical, nearly uniform at the two poles or with the hinder end somewhat pointed, flexible, uniformly ciliate Mouth terminal, situated at the anterior pole, generally with no specially large cilia round it, pharynx absent, or when present a short simple tube without or with weakly-developed rod-apparatus Anal aperture situated at the posterior extremity Contractile vacuole usually single, terminal, sometimes with a few smaller ones in its neighbourhood, or more numerous and arranged in rows Macronucleus spherical, oval, kidney-shaped, horseshoe-shaped, or elongated band-shaped Micronucleus small, oval They form spherical cysts surrounded by a gelatinous case inside which in certain cases numerous small swarm-spores are produced by rapid and repeated fission Fresh water and marine, sometimes parasitic on freshwater fish

Key to Indian Species

1	Cytopharynx absent	2
2 (5)	Contractile vacuole terminal or sub terminal	3 [p 79
3 (4)	Macronucleus rounded or oval	*H simplex* Schew,
4 (3)	Macronucleus band shaped	*H indica* Bhatia, [p 78
5 (2)	Contractile vacuole not terminal or sub terminal	6
6 (9)	Macronucleus single	7
7 (8)	Macronucleus spindle-shaped, contractile vacuole lateral in the posterior fourth	[Ghosh, p 77 *H bengalensis*
8 (7)	Macronucleus rounded, contractile vacuole lateral, about the middle	[p 79 *H lateralis* Kent,
9 (6)	Macronuclei two, contractile vacuole lateral, in the anterior half	[Ghosh, p 77 *H annandalei*

19 **Holophrya annandalei** Ghosh

†*Holophrya annandalei*, Ghosh, 1919 *a*, p 41, 1921 *a*, p 7

Body cylindrical, rounded at both ends, three times as long as broad Ciliary striæ faint Cytostome antero-terminal and circular, cytopharynx a slight depression Contractile vacuole single, placed at the junction of the anterior and middle thirds of the body, on one side Macronuclei two, spherical, one situated in the middle on one side and the other towards the anterior end

Dimensions —Length 150–220 μ

Remarks —No figure of the form is given by the author of the species The position of the macronuclei is very unusual for a species of this genus

Habitat —Fresh water BENGAL, Calcutta

20 **Holophrya bengalensis** Ghosh (Fig 19)

†*Holophrya bengalensis*, Ghosh, 1919 *a*, p 41, fig 1
Holophrya bengalensis, Kahl, 1930–5, p 50, fig 5, 8

Body cylindrical with rounded ends, slightly stouter posteriorly Cilia long Cytostome small and circular, at

Fig 19

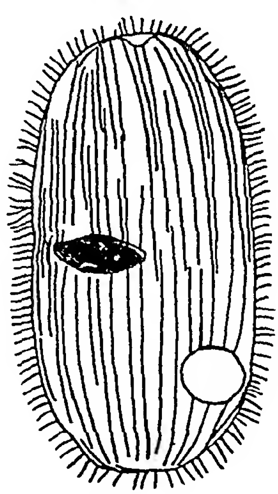


Fig 20

Fig 19 —*Holophrya bengalensis* Ghosh (After Ghosh)
Fig 20 —*Holophrya lateralis* Kent (After Kahl)

anterior end Cytopharynx absent Contractile vacuole single, subterminal, situated close to one side Macronucleus broadly fusiform, situated in the middle of the body, near one side

Dimensions —Length 75 μ, width 37 μ

Remarks —Description of the species is based on the examination of a single specimen by Ghosh

Habitat —Fresh water BENGAL, Calcutta

21 **Holophrya indica** Bhatia (Fig 21)

†*Holophrya indica*, Bhatia, 1916, p 178, fig 1
Holophrya indica, Kahl, 1930–5, p. 50, fig 5, 6

Body evenly elliptical, of medium size, a little more than one and a half times as long as broad , colourless , cuticular surface presenting distinct alternating longitudinal striæ and furrows Ciliation uniform, cilia fairly long and distinct,

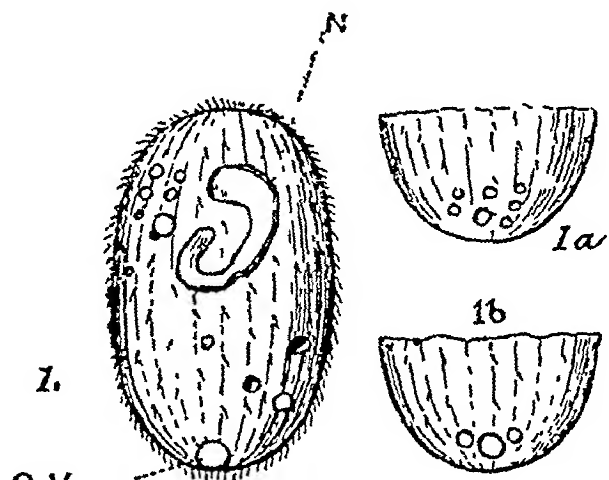


Fig 21 —*Holophrya indica* Bhatia 1, whole animal , 1 *a*, posterior end, showing one principal and six subsidiary vacuoles , 1 *b*, posterior end, showing one principal and two subsidiary vacuoles *N*, macronucleus , *C V* , contractile vacuole or vacuoles (After Bhatia)

disposed along the longitudinal striæ Border of the oral aperture not projecting, pharynx absent Contractile vacuole single, spherical, postero-terminal, with a number of small circular feeding-vacuoles in its neighbourhood which are not arranged in longitudinal rows Macronucleus large, band-shaped, curved in a horseshoe-shaped manner, situated in the anterior half of the body

Dimensions —Length 105 μ, width 63 μ

Remarks —The body showed only a slight degree of flexibility, and was almost equally rounded at the anterior and

posterior ends On the surface presented to view thirteen longitudinal striæ, along which the cilia were disposed, were distinctly made out The single spherical contractile vacuole, situated near the posterior pole, was surrounded by 5 to 7 small feeding vacuoles at the commencement of its diastolic phase These were seen to contract, and there would remain three only, the central one considerably larger than the two subsidiary ones now left This main contractile vacuole then contracted and disappeared, the others following almost simultaneously and contributing to the formation of the vacuole afresh, the neighbouring subsidiary ones soon making their appearance again (fig 21, 1 *a*, 1 *b*)

This species shows some resemblance to *H simplex* in the absence of trichocysts and pharynx, but differs considerably from it in the size of the body and the form of the macronucleus

Habitat —Fresh water PUNJAB, Lahore

22 **Holophrya lateralis** Kent (Fig 20)

†*Holophrya lateralis*, Kent, 1880–2, p 500, pl xxvi, fig 46
Holophrya lateralis, Lepsi, 1926 *a*, p 37, fig 27, Kahl, 1930–5, p 50 fig 5, *9*

Body cylindrical, oval or elliptical, a little over twice as long as broad, flexible Cilia conspicuous, arranged in numerous closely approximated longitudinal rows Endoplasm thickly granular Contractile vacuole single, lateral, a little in front of the middle Macronucleus inconspicuous

Dimensions —Length 250 μ

Remarks —The species was described by Kent from the figure and description contained in manuscript notes of H J Carter

Habitat —Fresh water BOMBAY

23 **Holophrya simplex** Schewiakoff (Fig 22)

Holophrya simplex, Schewiakoff, 1889, pp 30–1, pl ii, fig 31, 1893, p 45, 1896, pp 120–1, pl i, fig 1, Roux, 1901, p 20, pl i, fig 2
†*Holophrya simplex*, Gulati, 1925, p 745, pl i, fig 1
Holophrya simplex, Lepsi, 1926 *a*, p 37, Schoenichen, 1927, p 178, fig 700; Kahl, 1930–5, p 49, fig 5, *10*

Body ellipsoid, not contractile Cilia small, close-set, in 18–20 longitudinal rows Cytostome small, polar, only visible at the time of ingestion, without trichocysts or trichites Cytopharynx absent Anus and contractile vacuole postero-terminal Macronucleus large, rounded

Dimensions.—Length 34μ, width 18μ.

Remarks.—The form described and figured by Gulati differs from the description of the species as given above in size,

Fig. 22.

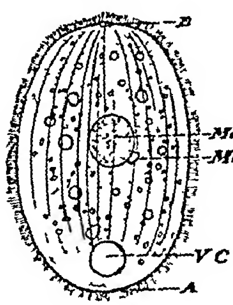


Fig. 23.

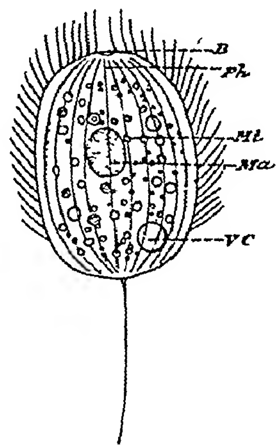


Fig. 24.

Fig. 22.—*Holophrya simplex* Schew. *A*, anus; *B*, cytostome; *Ma*, macronucleus; *Mi*, micronucleus; *Ph*, cytopharynx; *V.C.*, contractile vacuole. (After Roux.)

Fig. 23.—*Urotricha globosa* Schew. Lettering as in fig. 22. (After Roux.)

Fig. 24.—*Prorodon edentatus* Clap. & Lach. *a*, anus; *al*, alveolar layer; *C.V.*, contractile vacuole; *N*, macronucleus; *o*, cytostome; *oe*, cytopharynx. (After Schewiakoff.)

being 52μ by 39μ, in the macronucleus being oval, and the contractile vacuole being subcentral.

Habitat.—Fresh water. PUNJAB, Lahore.

Genus **UROTRICHA** Claparède & Lachmann, 1858.

Pantotrichum, Ehrenberg, 1830, p. 39.

Urotricha, Claparède & Lachmann, 1858–61, p. 314; Fromentel, 1874, p. 189; Kent, 1880–2, p. 504; Schewiakoff, 1889, p. 7; 1896, p. 124; Roux, 1901, p. 21; Penard, 1922, pp. 17–20; Calkins, 1926, pp. 381, 403; Lepsi, 1926 *a*, p. 34; Schoenichen, 1927, p. 179; Sandon, 1927, p. 171; Kahl, 1930–5, p. 57.

Animalcules small, free-swimming, spherical or elliptical, entirely ciliate; motion of cilia irregular and independent. Posterior end of the body provided with one or more setæ. Mouth antero-terminal or slightly subpolar, pharynx present. Contractile vacuole near the posterior end. Macronucleus oval or spherical. Fresh water.

24 **Urotricha globosa** Schewiakoff (Fig 23)

Urotricha globosa, Schewiakoff, 1889, p 33, pl ii, fig 33, 1893, p 46, 1896, p 127, pl i, fig 8, Roux, 1901, p 22, pl i, fig 7
†*Urotricha globosa*, Bhatia, 1916, p 179
Urotricha globosa Lepsi, 1926*a*, p 38, fig 33, Schoenichen, 1927, p 179, pl xii, fig 2, Kahl, 1930–5, p 59, fig 6, *11*.

Body small, spherical to egg-shaped Cilia long, near the mouth shorter and finer, scantier or absent at the posterior end, posterior end with one or two setæ Mouth at the anterior pole, pharynx long Macronucleus spherical and accompanied by a small micronucleus Locomotion swift, animalcule often changing its direction

Dimensions —Length 15–18μ, width 13–15μ

Remarks —The animalcules examined at Lahore closely resembled the description of the species They showed swift movement, often changing their direction suddenly, and the posterior springing bristle was elongated in the direction of the long axis of the body A few points of difference were, however, observed the macronucleus, which was spherical, was seen to be proportionately larger in size than in the figure given by Roux, the contractile vacuole was placed in the median line near the posterior end and not on one side, and there were cilia on the posterior part of the body in the neighbourhood of the springing bristle also As regards the first two points there is agreement with the figure given by Schewiakoff, but no cilia are indicated by him on the sides of the springing bristle This difference is not of sufficient importance to justify the creation of a new species

Habitat —Fresh water PUNJAB, Lahore

25 **Urotricha** sp

†*Urotricha* sp, Chaudhuri, 1929, p 54

Habitat —Soils from Calcutta and Bombay

Genus **PRORODON** Ehrenberg, 1833, emend Kahl, 1927

Prorodon, Ehrenberg, 1833, p 308, 1838, p 315, Fromentel, 1874, p 167, Kent, 1880–2, p 491, Schewiakoff, 1889, p 13, 1896, p 146, Roux, 1901, p 27, Penard, 1922, pp 36–43, Calkins, 1926, pp 378, 403, Lepsi, 1926*a*, p 34, Schoenichen, 1927, p 181, Sandon, 1927, p 171, Kahl, 1927*b*, p 44, 1930–5, p 72, Reichenow, 1929, p 1168

Animalcules small to very large, persistent in shape, symmetrically ovate, uniformly rounded at the poles, entirely and evenly ciliate throughout, with somewhat thicker cilia in the neighbourhood of the mouth Mouth at or closely

adjacent to the anterior pole, and the anal aperture at the opposite one Pharynx strengthened by rod-like teeth Contractile vacuole almost always single and terminal, rarely numerous and distributed over the whole body Macronucleus spherical, sometimes band-like and curved Cysts spherical, showing division or not Locomotion rapid and chiefly revolving on the longitudinal axis Fresh water and marine

Key to Indian Species

1 (4)	Cytopharynx with rod-apparatus	2
2 (3)	Body ellipsoidal, twice as long as broad, macronucleus oval or spherical, contractile vacuole single, postero terminal	*P teres* Ehr, p 84
3 (2)	Body oval, less than twice as long as broad, macronucleus horseshoe shaped, contractile vacuoles two	*P stewarti* Ghosh, [p 83
4	Cytopharynx without rod apparatus	5
5	Body elongate ellipsoidal, nearly three times as long as broad, macronucleus oval, contractile vacuole single, postero-terminal	*P edentatus* Clap & [Lach, p 82

26 **Prorodon edentatus** Claparède & Lachmann (Fig 24)

Prorodon edentatus, Claparède & Lachmann, 1858–61, pp 320–1, pl xviii, fig 1, Kent, 1880–2, p 493, pl xxvi, fig 43, Schewiakoff, 1896, p 152, pl i, fig 24

†*Prorodon edentatus*, Bhatia, 1922, p 27

Prorodon edentatus, Schoenichen, 1927, p 182, Sandon, 1927, p 174, Kahl, 1930–5, p 73

Body elongate-ellipsoidal, cylindrical, nearly three times as long as broad, transparent, surface of cuticle longitudinally striate Mouth terminal, somewhat eccentric, succeeded by a simple, conical and corneous tube-like pharynx, extending backwards and gradually diminishing in size, not provided with any rod-apparatus No trichocysts Cilia of the posterior extremity longer than those of the general surface, produced in a tuft-like manner Contractile vacuole, single, spherical, postero-terminal Macronucleus oval, elongate

Dimensions —Length up to 150μ

Remarks —The body was flexible, longitudinally striate, and with its anterior part more transparent The cilia were uniform all over the body, and the anterior end showed a small beak-like projection curved to one side The cytostome was anterior, eccentric, and was followed by a short, narrow, conical pharynx, without any cilia or rod-apparatus Macronucleus small, oval, and situated in the anterior half of the body The contractile vacuole very large and situated near the posterior end Anal aperture postero-terminal, situated

in a slight indentation of the posterior margin of the body An average specimen measured 74 μ by 24 μ

The form, however, differs from the type as described and figured by the original authors in the following features — The anterior and posterior margins of the body were not regularly rounded, there was no tuft of longer cilia at the posterior end, the pharyngeal tube did not extend to the centre of the body but only a short distance behind the anterior end, the macronucleus was proportionately much smaller and situated in the anterior half of the body All these features give the form found at Lahore a distinctive appearance, but do not justify the creation of a new species for it

Habitat —Fresh water PUNJAB, Lahore

27 **Prorodon stewarti** Ghosh (Fig 25)

†*Prorodon stewarti*, Ghosh, 1928, p 382, fig 1
Prorodon stewarti, Kahl, 1930–5, pp 73–4, fig 25, 21

Body elongately oval, less than twice as long as the greatest width, rounded at both ends Cilia arranged in close meridional rows Cytostome anterior and slightly lateral Cytopharynx

Fig 25

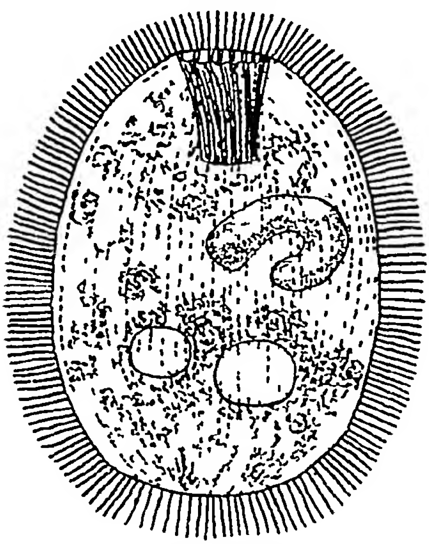


Fig 26

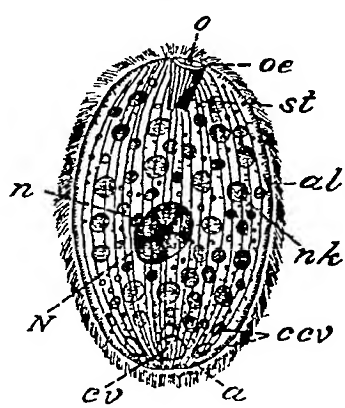


Fig 25 —*Prorodon stewarti* Ghosh (After Ghosh)
Fig 26 —*Prorodon teres* Ehrbg *a*, anus, *al*, alveolar layer, *ccv*, subsidiary vacuoles, *cv*, contractile vacuole, *N*, macronucleus, *n*, micronucleus, *nk*, food-vacuoles, *o*, cytostome, *oe*, cytopharynx with rod-apparatus, *st*, meridional rows of cilia (After Schewiakoff)

truncately conical, from one-fourth to one-third the length of the body, with distinct rod-apparatus Contractile vacuoles two, spherical, and placed, one a little in front of the other, in the posterior half of the body Macronucleus stout, horse-shoe-shaped, and placed laterally in front of the middle of the body *Micronucleus not identified*

Dimensions —Length 140–150 μ

Remarks —Kahl doubts if the form is a true *Prorodon* at all, as the position of the contractile vacuoles and the horseshoe-shaped macronucleus are unlike any other species of the genus He thinks that the position of its contractile vacuoles reminds one of *Holophrya haplostoma*, from which, however, it differs in several respects I do not feel disposed to agree with Kahl in questioning the form as a true *Prorodon*

Habitat —Sewer water BENGAL, Calcutta

28 **Prorodon teres** Ehrenberg (Fig 26)

Prorodon teres, Ehrenberg, 1838, p 316, pl xxxii, fig xi, Dujardin, 1841, p 501, Claparède & Lachmann, 1858–61, p 319

Prorodon griseus, Claparède & Lachmann, 1858–61, pp. 319–20, pl xviii, fig 3

Prorodon teres, Stein, 1859*d*, pp 82, 90, 95, 96, 100, 1867, pp 58, 65, 87, 99, 100, Engelmann, 1862, p 368

Prorodon ? teres, Fromentel, 1874, p 280, pl iii, figs 9, 9 *a*

Prorodon teres, Kent, 1880–2, p 492, Maupas, 1889, pp 272–5, pl xvi, figs 19–25, Bütschli, 1887–9, p 1682, pl xlii, fig 3, Schewiakoff, 1889, pp 13–14, pl i, figs 9–13, 1893, p 37, 1896, p 151, pl i, fig 22, pl vii, figs 188, 194, Roux, 1901, p 28, pl i, fig 16, Lang, 1913, p 38

†*Prorodon teres*, Bhatia, 1920, pp 259–60

Prorodon teres, Lepsi, 1926*a*, p 39, fig 46, Wenyon, 1926, figs. 24, 25, Schoenichen, 1927, p 182, pl xii, *5*, Reichenow, 1929, p 1168, Kahl, 1930–5, p 80, fig 8, *10–13*

Body ovate, ellipsoidal, twice as long as broad, slightly narrowed anteriorly Mouth exactly terminal, pharynx elongate, slightly conical, enclosing an elongate cylindrical fascicle of rod-like teeth No trichocysts Contractile vacuole single, postero-terminal Macronucleus oval or spherical, with a small micronucleus lying close to it

Dimensions —Length 63–200 μ

Remarks —The animals examined at Lahore measured 63–84 μ by 45 μ in size, and contained yellow or brown ingested food-particles The form, however, differed from the one figured by Schewiakoff in certain important respects The macronucleus was large and spheroidal, was situated in the anterior half of the body, and was carried about in the granular endoplasm, it was of the granular type, and a small rounded micronucleus was placed on its surface The cytostome

was anterior and terminal, but the pharynx did not extend as far back as figured The pharynx was 12μ in length and measured 9μ across at its anterior end, becoming somewhat narrower posteriorly The fascicle of rods was distinct, and eight rods could be counted in the surface presented to view The cilia on either side of the mouth were slightly longer than those over the rest of the body

Habitat —Fresh water PUNJAB, Lahore

29 **Prorodon** sp

Prorodon sp , Chaudhuri, 1929, p 54, pl iii, fig 8

Habitat —Soils from Indore and Colombo

Genus **LACRYMARIA** Ehrenberg, 1830

Lacrymaria, Bory, 1824 , *sic* Agassiz, *sed nem comp* (Sherborn)
Lacrymatoria, Bory de St. Vincent, 1824–7, p 479
Phialina, Bory de St Vincent, 1824–7, p 616
Lacrymaria, Ehrenberg, 1830, p 42 , 1831, pp 104–5 , 1838 pp 309–11
Phialina, Ehrenberg, 1838, pp 333–4
Lacrymaria, Claparède & Lachmann, 1858–61, pp 295–304
Phialina, Claparède & Lachmann, 1858–61, pp 304–6
Lacrymaria, Fromentel, 1874, p 174
Phialina, Fromentel, 1874, p 174
Lacrymaria, Kent, 1880–2, p 517
Phialina, Kent, 1880–2, p 519
Lacrymaria, Butschli, 1887–9, pp 1682–4 , Schewiakoff, 1896, p 138 , Roux, 1901, p 26 , Wenyon, 1926, pp 1163, 1175 , Schoenichen, 1927, p 183 , Reichenow, 1929, p 1168 , Kahl, 1930–5, p 89 , 1933, pp 53–4

Animalcules free-swimming, medium-sized to very large, subcylindrical or flask-shaped, narrowed anteriorly, apical region projecting like a stopper on the neck of a flask, separated from the rest of the body by a circular groove, and bearing one or more spiral rows of longer, usually reflected cilia Cytostome at the summit of the plug, and followed by a short, conical cytopharynx without rods Cuticular surface finely and entirely ciliate or sometimes glabrous Contractile vacuole single, postero-terminal, sometimes with one or two additional ones situated more anteriorly Macronucleus central, spherical to elongated or bipartite, micronuclei believed to be present Forming spherical cysts inside which multiplication takes place Fresh water and marine

Remarks —Bory de St Vincent (1824–7) first described a new genus *Lacrymatoria* with six species, and another as *Phialina* with five species Agassiz gives *Lacrymaria* Bory, 1824, also as a generic name, but this seems to be an error,

as this name is not to be found in 'Encyclopédie Méthodique' Ehrenberg revised both these genera, and remarked (1838) that out of the six (later eight) species described by Bory perhaps only one doubtfully belonged to *Lacrymaria* Ehrbg 1830, the others being referred to *Euglena*, *Phialina* and *Trachelocerca* The genus *Lacrymatoria* Bory, having been dismembered, the name *Lacrymaria* Ehrbg has always been adopted in later literature Ehrenberg established the genus *Lacrymaria* in 1830, and later transferred *Phialina proteus* Bory to it Of the remaining four species of *Phialina* Bory, he identified *Ph cygnus* with *Trachelocerca olor* (Muller), and identifying *Ph hirundinoides* with *Trichoda vermicularis* Muller, retained it in the genus *Phialina* as *Ph vermicularis* The two genera *Lacrymaria* and *Phialina* were regarded as distinct for a long time, the former described with the cytostome at the summit of the conical protuberance, and the latter with the cytostome in the furrow surrounding the base of the conical protuberance Butschli (1887–9) amalgamated *Lacrymaria* and *Phialina*, and transferred a number of other genera and subgenera to *Lacrymaria* Ehrbg He doubted if the position of the cytostome was antero-lateral in *Phialina*, and remarked that in case this position was confirmed later, *Phialina* would be regarded as a separate subgenus Since then the cytostome has been shown to lie at the summit of the conical protuberance, and the two genera completely merged

Key to Indian Species

1 (3)	Neck long, slightly flattened Macronucleus dumb bell-shaped Contractile vacuoles two	2
2	Body cylindrical, posteriorly pointed or rounded Cilia in spiral rows Animals swim with extended neck, now forwards, now backwards Length 100–400 μ	*L olor* (O F Mull), [p 87.
3 (1)	Neck short, thick Macronucleus oval Contractile vacuole single, posterior	4
4 (5)	Body sometimes green through the presence of zoochlorellæ Length about 120 μ Locomotion, briskly turning round	*L vermicularis* [(O F Mull), p 89
5 (4)	Body ellipsoid, tapering at the posterior end, with longitudinal and transverse striations Locomotion, calm and gliding, rotating on its axis Length 90 μ	*L striata* Gulati, [p 87

30 Lacrymaria olor (O F Muller) (Fig 27)

Vibrio olor, O F Muller, 1786, p 75, pl x, figs 12–15
Lacrymaria olor, Ehrenberg, 1831, p 105
Trachelocerca olor, Ehrenberg, 1833, p 316, 1838, p 342, pl xxxvii, fig 7
Lacrymaria proteus, Ehrenberg, 1838, p 310, pl xxxi, fig 17
Lacrymaria gutta, Ehrenberg, 1838, p 310, pl xxxi, fig 18
Trachelocerca viridis, Ehrenberg, 1838, p 342, pl xxxviii, fig 8
Trachelocerca biceps, Ehrenberg, 1838, p 343, pl xxxviii, fig 9
Lacrymaria olor, Dujardin, 1841, p 469
Lacrymaria proteus, Dujardin, 1841, p 470
Lacrymaria viridis, Dujardin, 1841, p 470
Lacrymaria gutta, Dujardin, 1841, p 471
Trachelocerca olor, Cohn, 1853, pp 265–6, pl xiii, figs 10, 11
Lacrymaria olor, Claparède & Lachmann, 1858–61, pp 298–302, pl xvi, figs 5–8
Trachelocerca viridis, Stein, 1859 *d*, p 65
Lacrymaria olor, Stein, 1867, pp 48, 65, 67, Fromentel, 1874, p 284, pl xv, fig 7
Trachelocerca versatilis, Kent, 1880–2, p 516, pl xxvii, fig 33
Lacrymaria olor, Bütschli, 1887–9, pp 1683–4, pl lvii, fig 9, Schewiakoff, 1893, p 38, 1896, pp 141–2, pl i, fig 17, Roux, 1901, p 26, pl i, fig 13
†*Lacrymaria olor*, Ghosh, 1921 *a*, p 7
Lacrymaria olor, Penard 1922, p 43, fig 44, Schoenichen, 1927, p 184, pl xii, fig 7, Kahl, 1930–5, p 93, fig 13, *22*, *25*

Body divided into two parts, one elongated, cylindrical, more or less pointed or simply rounded posteriorly, the other long and narrow, slightly flattened and extremely contractile Oral cone well developed Mouth small, pharynx little developed, with a circlet of large cilia surrounding the buccal cone No furrow separating the head from the neck Cilia arranged spirally Two contractile vacuoles, one at the junction of the neck with the trunk and the other in the posterior part of the body Macronucleus consists of two rounded parts united together Micronucleus in a depression of the macronucleus Animal swims with extended neck, now forwards, now backwards

Dimensions —Length 100–400 μ according to the state of extension of the neck, width variable

Habitat —Pond water and vegetable infusions BENGAL, Calcutta

31 Lacrymaria striata Gulati (Fig 28)

†*Lacrymaria striata*, Gulati, 1925, p 746, pl i, fig 3
Lacrymaria (*Enchelis*) *pupula*, Kahl, 1930–5, p 94, fig 13, *1*, *12*, *27*
Lacrymaria striata, Kahl, 1930–5, p 96

Body ellipsoid, neck short and thick, shaped like the cork of a bottle and surrounded by a ring of cilia, trunk tapering posteriorly to a narrow end Mouth at the summit of the

neck, without a pharynx Length of the body twice as much as the width, with the greatest width in front of the middle The whole of the body has a dark brown appearance except at the two ends, where it is transparent Surface marked by longitudinal and transverse striations Contractile vacuole single, occupying the whole of the narrow posterior end

Fig 27

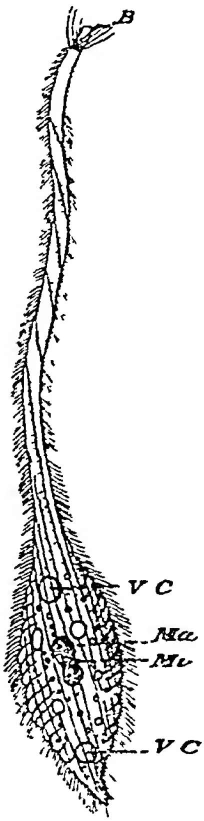


Fig 28

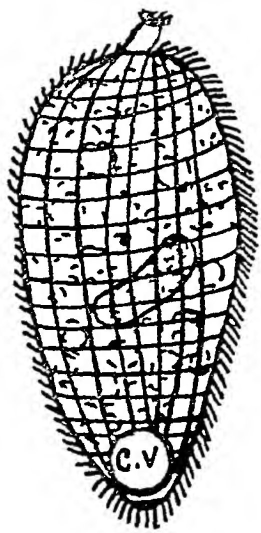


Fig 27 —*Lacrymaria olor* (O F Müll) *B*, mouth, *Ma*, macronucleus, *Mi*, micronucleus, *V C*, contractile vacuoles (After Roux)

Fig 28 —*Lacrymaria striata* Gulati *C V*, contractile vacuole (After Gulati)

Macronucleus oval, a little behind the middle of the body Micronucleus small, rounded, and lying a little in front of the macronucleus Locomotion calm and gliding, rotating round its axis

Dimensions —90 μ by 43 μ

Remarks —According to Kahl (1930–5) it is probably a stronger form of *L pupula* (O F Muller), of which species *L coronata*

Clap & Lach var *aqua dulcis* Roux is a synonym That the pellicle should have both longitudinal and transverse striations is very unusual for a *Lacrymaria* *L coronata* and *L pupula* show longitudinal striations, and if Gulati has correctly observed transverse striations this species indicates an approach to *Coleps*

Habitat —Stagnant water of a drain · PUNJAB, Lahore

32 **Lacrymaria vermicularis** (O F Muller) (Fig 29)

Trichōda vermicularis, O F Müller, 1786, p 198, pl xxviii, figs 1–4
Phialina vermicularis, Ehrenberg, 1831, p 111 , 1838, p 334, pl xxvi, fig 3 , Dujardin, 1841, pp 472–3 , Claparède & Lachmann, 1858–61, pp 304–5, pl xviii, fig 8
Lacrymaria vermicularis, Fromentel, 1874, pp 282–3, pl xv, figs 3, 3 *a*
Phialina vermicularis, Kent, 1880–2, p 519, pl xxvi, fig 36
Lacrymaria vermicularis, Butschli, 1887–9, p 1684 , Schewiakoff, 1896, pp 143–4
†*Lacrymaria vermicularis*, Bhatia, 1916, p 180, fig 2
Lacrymaria spiralis, Kahl, 1926, p 217
Lacrymaria vermicularis, Schoenichen, 1927, p 184 , Kahl, 1930–5, p 95, fig 13, *5–7*

Body cylindrical, ovate or pyriform, narrowest anteriorly, very contractile, apical portion in front of the annular furrow

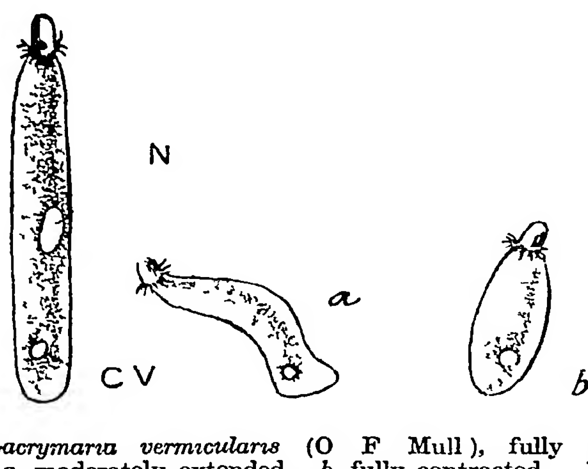


Fig 29 —*Lacrymaria vermicularis* (O F Mull), fully extended , *a*, moderately extended , *b*, fully contracted *N*, macronucleus , *C V* , contractile vacuole (After Bhatia)

short and thick, and bearing a single circlet of cilia which are usually directed backwards Oral aperture at the summit of the apical portion Surface of the body smooth or with short, close, fine cilia arranged in longitudinal or spiral rows Contractile vacuole single, spherical, postero-terminal Macronucleus oval, subcentral, obliquely directed

Dimensions.—Length about 120μ.

Remarks.—Body is subcylindrical, or bottle-shaped if the apical lobe is taken into consideration, flexible and contractile; the statement that it is two and a half times as long as broad (Kent, 1880–2, p. 519) appears to refer to the contracted state of the animal; in the fully extended condition it is four to six times as long as broad. Apical portion in advance of the annular furrow is short and cylindrical and bears at its base a single circlet of cilia which are directed backwards, the rest of the body is generally described as finely ciliate, though I found it glabrous, as was described by Ehrenberg and other early writers. The nucleus is oval in outline, and the single contractile vacuole is situated near the posterior end.

Kahl (1930–5) shows his examples to be spirally striated and the body bearing cilia.

Habitat.—Fresh water. PUNJAB, Lahore.

Genus ENCHELIS O. F. Muller, 1773.

Enchelis O. F. Muller, 1773, p. 33.
Enchelys Nitzsch, 1817, p. 125; Ehrenberg, 1838, p. 209; Claparède & Lachmann, 1858–61, pp. 294, 309–12; Fromentel, 1874, p. 187; Kent, 1880–2, p. 509; Roux, 1901, p. 23; Schoenichen, 1927, p. 180; Kahl, 1930–5, p. 96.

Animalcules free-swimming. Body elongated or egg-shaped, with anterior end narrowed, drawn out and obliquely truncate and posterior end rounded. Mouth antero-terminal, pharynx absent, anus postero-terminal. Cilia short, fine, with a fringe of larger cilia encircling the oral region. Contractile vacuole single and terminal or numerous and arranged in a longitudinal row. Macronucleus subcentral, spherical or oval. Inhabiting marsh and stagnant water and in infusions.

33. Enchelis arcuata Claparède & Lachmann. (Fig. 30.)

Enchelys arcuata, Claparède & Lachmann, 1858–61, p. 311, pl. xvii, fig. 4; Kent, 1880–2, p. 510, pl. xxvii, fig. 14; Schewiakoff, 1896, p. 130, pl. i, fig. 10.
†*Enchelys arcuata*, Bhatia, 1916, p. 179.
Enchelys arcuata, Lepsi, 1926 *a*, p. 38, fig. 39; Schoenichen, 1927, p. 180, pl. xii, fig. 3; Kahl, 1930–5, p. 96, fig. 12, *21*.

Body pyriform, attenuate anteriorly. Cilia of general surface very short and fine. Contractile vacuoles several, arranged in an arcuate manner along the margin of the body. Macronucleus elongate-oval.

Dimensions.—Length about 80μ.

Remarks.—Body is rounded posteriorly, attenuated anteriorly. Length 80μ, maximum width 30μ. The animal

is broadest at one-fourth of the length of the body from the posterior end, and begins to taper rapidly in the anterior fourth Anterior end is obliquely truncate and is occupied by the mouth Cilia covering the whole body are very fine, rather longer ones surrounding the oral end

Habitat —Infusion of leaves - PUNJAB, Lahore.

Fig 30

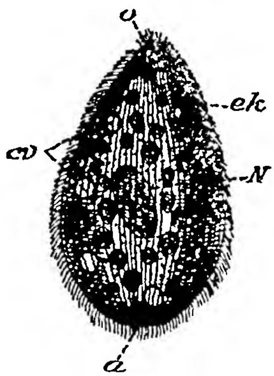


Fig 32

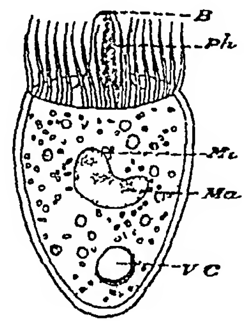


Fig 31

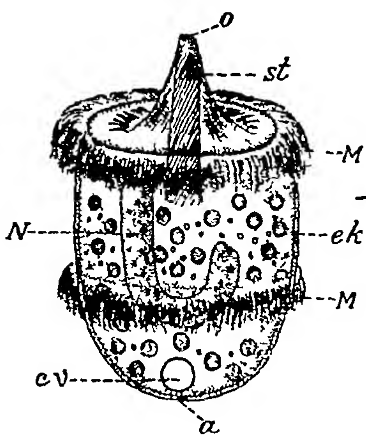


Fig 33

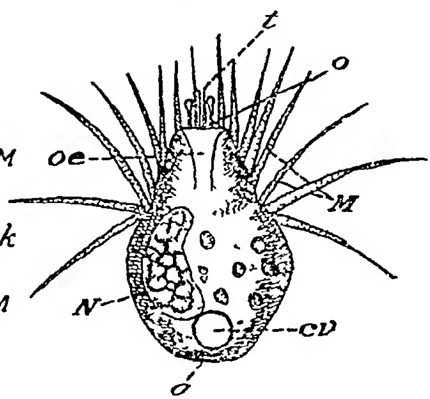


Fig 30 —*Enchelis arcuata* Clap & Lach *a*, anus, *cv*, contractile vacuole, *ek*, ectoplasm, *N*, macronucleus, *o*, oral aperture (After Schewiakoff)

Fig 31 —*Didinium nasutum* (O F Mull) *M*, wreath of cilia, *st*, seizing organ with trichocysts Other lettering as in fig 30 (After Schewiakoff)

Fig 32 —*Didinium balbiani* (Fabre Dom.) *B*, mouth, *Ma*, macronucleus, *Mi*, micronucleus, *ph*, pharynx, *v c*, contractile vacuole (After Roux)

Fig 33 —*Mesodinium pulex* (Clap & Lach) *a*, anus, *cv*, contractile vacuole, *M*, membranellæ, *N*, macronucleus, *o* oral aperture, *oe*, pharynx, *t*, tentacles (After Schewiakoff)

34 Enchelis sp

†*Enchelys* sp , Sandon, 1927, p 172, Chart III

Habitat —Farm and garden soil SOUTH INDIA, Coimbatore

35 Enchelis sp

†*Enchelys* sp , Chaudhuri, 1929, p 54, Table III

Habitat —Soil from cultivated fields PUNJAB, Lahore, Lyallpore , BENGAL, Sibpore

Genus CHÆNEA Quennerstedt, 1867

Chænea, Quennerstedt, 1867, p 15
Chœnia, Kent, 1880–2, p 521
Chænia, Schewiakoff, 1896, p 154 , Roux, 1901, p 29
Chœnia, Schoenichen, 1927, p 182
Chænea, Kahl, 1930–5, p 103

Body elongated, somewhat cigar-shaped Cilia fine, arranged spirally Mouth slit-like, at the anterior extremity, often surrounded by a brush-like tuft of larger cilia

36 Chænea sp

Chœnia sp , Chaudhuri, 1929, p 60

In his Table IV Chaudhuri mentions a species of this genus as having been recorded by Sandon from South India and Burma, but reference to Sandon's monograph shows that he did not record it from India

Genus TRACHELOCERCA Ehrenberg, 1840

Trachelocerca, Ehrenberg, 1840, p 316 , Cohn, 1866, p 264 , Kent, 1880–2, p 514 , Butschli, 1887–9, p 1684 , Calkins, 1926, pp 381, 403 , Lepsi, 1926 *a*, p 33 , Kahl, 1930–5, p 116

Elongated, more or less flexible, plump to very slender vermiform or flask-shaped form, not flattened Oral cone 2–4-lobed , with circlet of cilia and no constriction marking off the anterior portion

Remarks —This genus is distinguished from the closely-related *Lacrymaria* by the absence of a groove marking off a neck-like constriction, and from *Chænea* by the anterior end not being narrowed into a neck-like portion and by the body not showing spiral striations during contraction

37 Trachelocerca sp

Trachelocerca sp , Simmons, 1891, p 4

Habitat —Pond water BENGAL, Calcutta

2. Family DIDINIIDÆ Poche, 1913.

Body spheroid or ellipsoid Cytostome round, situated at the summit of an apical truncated cone, which is surrounded at its base by a ciliary girdle, with one or more ciliary girdles situated more posteriorly Rest of the body uniformly ciliated or naked

Key to Indian Genera

Body with one or two circlets of membranelles, rest of the body without cilia	DIDINIUM St, p 93
Body with an equatorial furrow containing one or more girdles of cirri, cytostome surrounded by small tentacles .	MESODINIUM St, [p 95

Genus **DIDINIUM** Stein, 1859

Didinium Stein, 1859 *a*, p 5, Kent, 1880–2, p 638, Schewiakoff, 1889, p 15, 1896, p 178, Roux, 1901, p 32, Schoenichen, 1927, p 187, Kahl, 1930–5, p 123

Animalcules free-swimming, large, ovoid, flat or deepened in front From the middle of the anterior end a conical process projects forward, at the summit of which lies the mouth-opening, which is capable of being widened considerably Cytopharynx provided with fine rods Body provided with one or more girdles of membranelles, which frequently break up into separate cilia, rest of surface without cilia Contractile vacuole and anal aperture posterior Macronucleus horseshoe-shaped Multiplication by transverse fission

38 **Didinium balbiani** (Fabre-Domergue) (Fig 32)

Monodinium balbiani, Fabre Domergue, 1888, pp 35–9, pl iv, figs 43–50

Didinium balbiani, Butschli, 1887–9, p 1688, pl lviii, figs 4 *a–b*, Schewiakoff, 1889, pp 15–17, pl ii, figs 14–21, 1896, pp 181–2, pl ii, fig 39, pl vii, fig 196, Roux, 1901, p 32, pl ii, fig 1

†*Didinium balbiani*, Bhatia, 1922, p 29

Didinium balbiani, Penard, 1922, p 56, fig 59

†*Didinium balbiani*, Gulati, 1925, p 746–7, fig 6

Didinium balbiani, Lepsi, 1926 *a*, p 40, fig 83, Schoenichen, 1927, p 187, pl xii, fig 10, Kahl, 1930–5, p 125, pl xviii, fig 24

Body ovate, rounded and narrower posteriorly, with the anterior broader end produced into a conical projection A single ciliary wreath near the base of the proboscis only. Contractile vacuole large and posterior Macronucleus band-like and curved, micronucleus situated close to one end Locomotion not so rapid as in *D nasutum*

Dimensions —Length 60–100μ

Remarks —The pellicle is said to be provided with very weak longitudinal striations, differing in number, according to the observations of different authors, from 6 to 12, wide apart according to Faure-Fremiet and close together according to Schewiakoff According to Faure-Fremiet isolated trichocysts are found in the ectoplasm Endoplasm colourless, granular This species is widespread, planktonic or on the surface of plants, rarely among detritus

Habitat —In the surface layer of clear swamp-water near the River Ravi PUNJAB, Lahore

39 **Didinium nasutum** (O F Muller) (Fig 31)

Vorticella nasuta, O F Müller, 1773, pp 102–4, 1786, pp 268–70, pl xxxvii, figs 20–4

Didinium nasutum, Stein, 1859*a*, p 5, 1867, pp 124, 148, 168, Engelmann, 1862, pp 375–6, Balbiani, 1873, pp 363–94, pl xviii, Kent, 1880–2, pp 638–9, pl xxxii, figs 50–7, Maupas, 1888*a*, pp 191–2, 1889, pp 276–7, pl xvi, figs 27–8, Butschli, 1887–9, p 1686, pl lviii, fig 3, Schewiakoff, 1896, p 182, pl ii, fig 40, Thon, 1905, pp 281–321, pls xii–xiii, & figs 1–3, Prandtl, 1906, pp 229–58, pls ix–x & 12 figs

†*Didinium nasutum*, Bhatia, 1916, p 180

Didinium nasutum, Penard, 1922, p 55, fig 58

†*Didinium nasutum*, Gulati, 1925, p 746, fig 5

Didinium nasutum, Bullington, 1925, p 269, Lepsi, 1926*a*, p 40, fig 84, Calkins, 1926, pp 154, 178, 216, figs 88, 89, Schoenichen, 1927, p 187, Kahl, 1930–5, p 125, fig 18, *20* & *22*, Beers, 1935, pp 133–55

Body oval or barrel-shaped, rounded posteriorly, the anterior border produced into a conical projection One wreath of cilia near the base of the proboscis, the other posterior to the middle of the body Ectoplasm without distinct trichocysts Contractile vacuole large, debouching upon the anal aperture Macronucleus band-like, curved Devours large Infusoria, revolves impetuously

Dimensions —Length 100–180μ

Remarks —Specimens found by me at Lahore measured on an average 123μ by 84μ Apparently this species is subject to large variations of size, as the dimensions given by different authors differ very widely Kent, for example, gives the length as 1/300 of an inch (83μ), while Conn and Edmondson state it to be 100–175μ The animalcule is often found attached to a *Paramecium* by its snout-like process

Besides the principal contractile vacuole situated posteriorly I found three or four subsidiary ones scattered in different parts of the body These were carried towards the principal vacuole by circulation of the protoplasm and absorbed into it one by one In one case two of these vacuoles reached the

principal vacuole at about the same time, the one that touched it first was absorbed into it, the other had to wait for its turn

Habitat—Pond water, in the dusty upper surface of water or amidst decaying vegetation PUNJAB, Lahore

Genus MESODINIUM Stein, 1862

Mesodinium, Stein, 1862 *b*, p 162, 1867, p 148, Kent, 1880–2, p 635
Acarella, Kent, 1880–2, p 636
Mesodinium Butschli, 1887–9, p 1686, Schewiakoff, 1896, p 183, Roux, 1901, pp 32–3, Calkins, 1926, p 404, Sandon, 1927, p 175, Reichenow, 1929, p 1170

Body ovate or pear-shaped, divided into two unequal parts by an equatorial furrow, anterior conical and posterior spherical In the groove are situated one or more girdles of larger cilia, which are united in groups to form membranelles The remaining part of the body is naked Cytostome at the anterior end of the snout often surrounded by small tentacles Cytopharynx more or less elongated, conical, provided with rods Anus posterior Contractile vacuole in the close neighbourhood of the anus Macronucleus spherical or ovoid Locomotion irregular, quick

40 Mesodinium pulex (Claparède & Lachmann) (Fig 33)

Halteria pulex, Claparede & Lachmann, 1858–61, p 370, pl xiii, figs 10–11
Acarella siro, Cohn, 1866, pp 293–4, 301, pl xv, figs 32–4
Mesodinium pulex, Stein, 1867, p 162
†*Halteria pulex*, Carter, 1869, pp 259–60, pl xvii, fig 23
Mesodinium pulex, Kent, 1880–2, p 636, pl xxxii, fig 44
Acarella siro, Kent, 1880–2, pp 636–7, pl xxxii, fig 45, Mereschkowsky, 1882, pp 1232–4, 1883, pp 276–9
Mesodinium pulex, Maupas, 1882, pp 1381–4, 1883, pp 516–8, Gourret & Roeser, 1886, pp 491–3, pl xxx, fig 13, Bütschli, 1887–9, pl lviii, fig 5, Schewiakoff, 1896, pp 185–6, pl ii, fig 42, Penard, 1922, pp 58–61, figs 62, 63, Lepsi, 1926, p 40, fig 90, Kahl, 1930, p 127, fig 18, *7*, *8*

Body egg-shaped, globose posteriorly, conical and tapering as it approaches the anterior projecting snout, two wreaths of cirrose membranelles developed on an annular groove, those of the anterior spread in different directions, those of the posterior directed spirally backwards to the left, the rest of the surface of the body naked Mouth at the anterior end, surrounded by 4 to 8 forwardly directed tentacles Pharynx more or less elongated, conical, provided with rods Anus posterior Contractile vacuole postero-lateral Endoplasm

with large, colourless food-particles Macronucleus of two spherical parts Locomotion irregular, swift

Pelagic or among detritus in salt or fresh water

Dimensions —Length 20–30 μ, or according to some up to 40 μ

Remarks —Claparède and Lachmann, who described this species under the title ***Halteria pulex***, showed it as possessing three long bristle-like processes in advance of the mouth Stein regarded these simply as three forwardly-directed locomotive cirri, but Kent interpreted them as an optical misinterpretation of the everted attenuate proboscis Kahl has shown that these tentacles are provided distally with suckers and serve to attach the organism during intervals of rest According to him the tentacles are not always recognizable The macronucleus is shown as a single rounded body by Kent and by Blochmann, and as kidney-shaped by Schewiakoff According to Penard there are always two small macronuclei, one to the right and the other to the left of the median line, a little way behind the transverse furrow

Habitat —Fresh water Bombay

3 Family COLEPIDÆ Claparede & Lachmann, 1858

Body barrel-shaped or pointed posteriorly, covered with an ectoplasmic armour of regularly arranged plates Anterior end of the body truncated, surrounded by the teeth-like ends of the plates Cilia arranged in longitudinal rows, those near the mouth more strongly developed Cytostome apical, surrounded by cirri-like structures Cytopharynx wide, funnel-shaped, provided with rod-apparatus

Genus **COLEPS** Nitzsch, 1817

Coleps, Nitzsch, 1817, p 69, Ehrenberg, 1838, p 317, Dujardin, 1841, p 565, Claparède & Lachmann, 1858–61, p 364, Fromentel, 1874, p 191, Kent, 1880–2, p 506, Bütschli, 1887–9, p 1686, Schewiakoff, 1896, p 166, Roux, 1901, p 30, Noland, 1925, pp 3–13, Schoenichen, 1927, p 185, Kahl, 1930–5, p 131

Animalcules free-swimming, small to medium-sized, more or less barrel-shaped, Anterior end truncate, surrounded by teeth-like projections Cuticular surface usually longitudinally and transversely furrowed, and thus divided into numerous symmetrical quadrangular facets forming a coat of mail,

quadrangular facets smooth and indurated, the narrow intervening furrows soft and clothed with cilia Mouth apical, terminal, surrounded with cilia of slightly larger size than those of the general surface, pharynx wide, funnel-shaped, and provided with rod-apparatus, anal aperture postero-terminal Contractile vacuole single and terminal Macronucleus rounded, with a micronucleus lying close to it Posterior end of the body rounded and generally provided with spines

Divides by transverse fission Locomotion rapid, constantly revolving and often changing the direction Frequently containing zoochlorellæ Marine and fresh water

Key to Indian Species

1 (4)	With posterior spines	2
2 (3)	Three posterior spines, 20 longitudinal rows of plates, body fairly plump length 40–65 μ	[p 97 *C hirtus* (O F Mull),
3 (2)	Four posterior spines length 60–70 μ	*C uncinatus* Clap & [Lach, p 100
4 (1)	Without posterior spines length about 52 μ	*C lenti* Bhatia, p 98

41 Coleps hirtus (O F Muller) (Fig 34)

Cercaria hirta, O F Muller, 1786, p 128, pl xix, figs 17–18
Coleps hirtus, Nitzsch, 1817, p 4, Ehrenberg, 1830, p 42, 1831, p 100, 1838, p 317, pl xxxiii, fig 1, pl xxxv, fig 1, Dujardin, 1841, pp 566–7, pl xvi, fig 10, Claparède & Lachmann, 1858–61, p 366, Pritchard, 1861, p 616, pl xx v, figs 284–6, Engelmann, 1862, p 350, Stein, 1867, p 118, Fromentel, 1874, p 311 pl xxii, fig 25, Kent, 1880–2, p 506, pl xxvii, figs 3, 4, Maupas, 1885, pp 337–67, pl xvii, 1888*a*, p 236, 1889, p 271, pl xvi, fig 13, Bütschli, 1887–9, pp 1686–7, pl lviii, fig 1, Schewiakoff, 1893, p 38, 1896, pp 169–70, pl ii, fig 35, Roux, 1901, p 30 pl i, fig 19
†*Coleps hirtus*, Bhatia, 1916, p 180, Ghosh, 1921, p 7, Gulati, 1925, p 747, fig 4
Coleps hirtus, Noland, 1925, pp 6–7, pl i, fig 3, Bullington, 1925, p 266, Lepsi, 1926*a*, p 41, fig 86, Calkins, 1926, pp 128, 374, figs 65, 164, Sandon, 1927, p 175, Schoenichen 1927, p 186, pl xii, fig 9
†*Coleps hirtus*, Bhatia & Mullick, 1930, p 391
Coleps hirtus, Kahl, 1930–5, p 134, fig 19, *1*, *2*

Body barrel-shaped, about twice as long as broad, rounded posteriorly, slightly narrower and truncate in front, anterior margin denticulate, posterior extremity provided with three spines Cuticular surface divided into quadrangular areas Colour whitish or light brown Contractile vacuole single, posteriorly situated Macronucleus spherical, subcentral

Dimensions —Length 40–65 μ

Remarks—Specimens of this cosmopolitan species are quite commonly met with in ponds, and whenever encountered are found in abundance Individuals exhibit considerable differences in size and appearance Specimens taken in

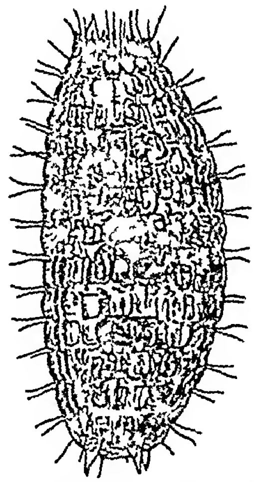


Fig 34—*Coleps hirtus* (O F Mull) (After Noland)

Lahore are generally 40μ by 20μ in size, but those found in Srinagar were larger, measuring from 48 to 60μ in length

Habitat—Pond water KASHMIR Srinagar, PUNJAB, Lahore, BENGAL, Calcutta

42 Coleps kenti Bhatia (Fig 35)

Coleps hirtus (part), Kent, 1880–2, p 507
†*Coleps kenti*, Bhatia, 1922, p 28
Coleps striatus, Kahl 1930–5, p 137, fig 19, *20, 21*

Body barrel-shaped, only one and one third as long as broad, rounded posteriorly, broad and truncate anteriorly, not provided with apical projections and posterior spines Cuticular surface divided into quadrangular areas by longitudinal and transverse furrows, the latter dividing the body into four chief girdles Contractile vacuole and anal aperture posterior Macronucleus spherical, subcentral

Dimensions—Length 52μ, width 39μ

Remarks—This species differs from *C hirtus* in being proportionately much broader and in the absence of apical projections and posterior spines Kent also had observed forms "in which no cusps whatever were developed at the posterior extremity, the size, quadrangular corrugation, and deeper longitudinal lines of furrows being, in common

with all other structural details, identical with what obtains in *C hirtus* . While the comparative length and breadth range in most instances in the proportion of two to one, much shorter and almost subspherical specimens were not infrequently encountered" He, however, thought that this well-marked variety should perhaps be properly referred to the genus *Plagiopogon* But the genus *Plagiopogon* was founded by Stein for *Coleps*-like forms which, though not possessing apical or posterior spines, are only longitudinally furrowed, and the surface is neither marked off into quadrangular areas nor bears a coat of mail, as *Coleps* does The form encountered by me is practically the same as that described by Kent, and regarded by him as a distinct variety of or a most closely allied species to *C hirtus,* except that I did not find

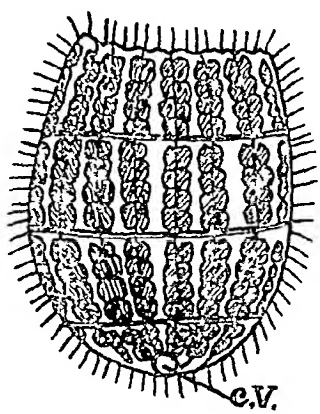


Fig 35 —*Coleps kenti* Bhatia *C V* , contractile vacuole (After Bhatia)

the proportion of length to breadth as two to one For the reason mentioned above I would not refer Kent's form and mine to *Plagiopogon*, but consider that they merit separate specific distinction

Noland (1925) in his monograph on the genus *Coleps* has overlooked this species In the species recognized by Noland a number of posterior spines are always present, but in *C. kenti* there are no posterior spines, though the body is covered with a coat of mail Referring to Kent's original description, Noland thinks that, if it is not a *Plagiopogon*, it is the simplest type of *Coleps* yet observed Kahl (1930–5) considers my species as synonymous with *Coleps striatus* Smith, 1897, and *Coleps inermis* Perty, 1852 I have not access to the original works of Smith and Perty, but on comparing my figure with those of *C striatus* and *C inermis*,

as reproduced by Kahl, I find that my form is quite distinct It is proportionately broader and more clearly marked into quadrangular facets

Habitat—Pond water PUNJAB, Lahore

43. Coleps uncinatus Claparède & Lachmann (Fig 36)

Coleps uncinatus, Claparède & Lachmann, 1858–61, p 366, pl xii, fig 9, Kent, 1880–2, p 507, pl xxvii, fig 6, Schewiakoff, 1896, p 171, Roux, 1901, p 30, pl i, fig 20

†*Coleps uncinatus*, Bhatia, 1922, p 29

Coleps uncinatus, Noland, 1925, p 8, fig 1 *b*, Lepsi, 1926*a*, p 41, Schoenichen, 1927, p 186, fig 712, Kahl, 1930–5, p 135, fig 19, *11*

Body ovate, slightly flattened ventrally, two and a half times as long as broad, the anterior margin bearing two spines

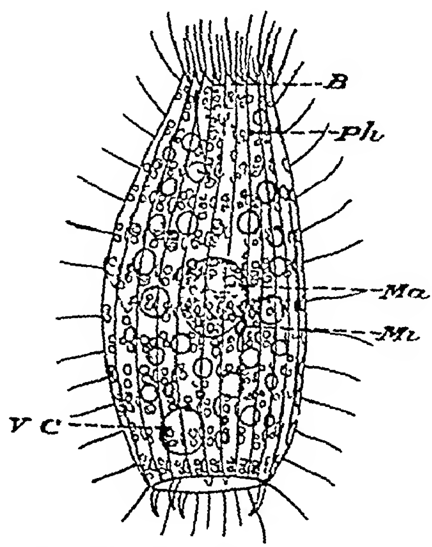


Fig 36—*Coleps uncinatus* Clap & Lach *B*, mouth *Ma*, macronucleus, *Mi*, micronucleus, *Ph*, pharynx, *V C*, contractile vacuole (After Roux)

on the more flattened ventral side, four acuminate spines developed at the posterior extremity Contractile vacuole single, posteriorly situated Macronucleus discoidal, central, micronucleus situated close by Rare and living in mud

Dimensions—Length 60–70 μ, width 28–33 μ

Remarks—The average size of my specimens was 70 μ by 28 μ, and the body was elongated oval and provided with four posterior spines On staining with acetic methyl-green the spherical macronucleus and the small micronucleus situated close by it were observed On the ventral anterior margin

are two spines or hooks which, according to Claparède and Lachmann (1858–61), are recurved, but are shown by Roux (1901) as straight and pointing forward. In the latter case, according to Noland (1925), they do not differ materially from the longer teeth that may be seen at the lateral angles of the mouth of nearly all species of *Coleps*

Habitat —Pond water · PUNJAB, Lahore

44 **Coleps sp**

Coleps sp , Simmons, 1891, p 4

Habitat —Pond water BENGAL, Calcutta.

4. Family SPATHIDIIDÆ Kahl, 1930.

Body oval or cylindrical, with truncated anterior end. Cilia arranged in longitudinal rows Cytostome anterior, slit-like, surrounded by a laterally compressed, more or less prominent, padded margin, which bears trichocysts

Genus SPATHIDIUM Dujardin, 1841

Spathidium, Dujardin, 1841, p 457 , Butschli, 1887–9, p 1680 , Roux, 1901, p 23 Hickson, 1903, pp 397, 398 , Penard, 1922, p 23 , Lepsi, 1926 *a*, p 39 , Calkins, 1926, p 404 , Schoenichen, 1927, p 180 , Reichenow, 1929, p 1171 , Kudo, 1931, p 350 ; Kahl, 1930–5, p 149

Animalcules free-swimming, medium-sized to large , body nearly purse-shaped, flexible, anterior end truncated and generally wholly taken up by the slit-like mouth , margins of the mouth padded and thickened Without pharynx Cilia fine, short, in longitudinal rows, somewhat longer on the thickening round the mouth Contractile vacuole terminal or varying in number and position Anus at the posterior end Macronucleus round to elongated and rosary-shaped Micronuclei one to many Cysts spherical

45 **Spathidium moniliforme** Bhatia (Fig 37.)

†*Spathidium spathula* var *moniliforme*, Bhatia, 1920, p 259
Spathidium spathula, Penard, 1922, p 23, fig 16
†*Spathidium spathula*, Gulati, 1925, p 745, pl i, fig 2
Spathidium moniliforme, Kahl, 1930–5, p 158, fig 22, *3*

Body elongated, flask-shaped, flexible but not deformable , anterior end obliquely truncate and occupied almost completely by the narrow and elongated slit-like mouth , margins

of the oral portion padded and provided with longer cilia Ciliary lines on the general surface of the body close and provided with fine and short cilia Trichocysts small, fusiform and more numerous round the mouth Large contractile vacuole at the posterior end of the body Macronucleus elongated, consisting of a number of beads, which are sometimes disjointed

Dimensions —Length up to 260μ

Remarks —The animals were found in large numbers The body was flask-shaped, flexible though not very contractile, the anterior end was narrower than the middle of the body, obliquely truncate and occupied almost completely by the narrow and elongated slit-like mouth The margins of the oral portion were padded The general surface of the body

Fig 37 —*Spathidium moniliforme* Bhatia *C V*, contractile vacuole, *N*, macronucleus, *O* mouth (After Bhatia)

appeared to be striate Cytoplasm was granular and the anterior part of the body somewhat clearer and more transparent Ciliation was uniform, with somewhat longer cilia round the anterior end The movements of the animal were slow, the anterior part of the body occasionally bending slightly

This form differs from *S spathula* O F Muller in its much smaller size and in the character of the nucleus The animals measured only 105μ by 20μ, instead of the usual size of the species, which is given as 180–240μ The macronucleus consisted of a long chain of small beads, which was bent upon itself In the generic characters given by Butschli the nucleus is said to be round to elongated and rosary-shaped, but in the figure of *S spathula* is shown as consisting of three

large beads only (plate lviii, fig 10) E André (1916), under the name *S spathula* var *plurinucleata*, described a form containing a large number of small, separate, rounded nuclei The form here described differs from the latter in that these small, separate, rounded nuclei are not irregularly scattered but are parts of an elongated rosary which is bent upon itself The form was originally described by me as a new variety of *S spathula*, but Kahl (1930) in his recent monograph considers *S plurinucleata* André and *S moniliforme* Bhatia to be distinct species and *S spathula* as described by Penard to be identical with the latter The size of the form described by Penard is mentioned as 240–260 μ long and 35–60 μ wide, and Penard has stated that the beads of the macronucleus are sometimes disjointed Gulati (1925) found specimens which were proportionately very much wider than mine, measuring 112 μ by 85 μ

Habitat —Pond water PUNJAB, Lahore

5. Family BUTSCHLIIDÆ Poche, 1913.

Parasites in the gut of the Ungulate mammals Ciliation over the whole body or reduced to a single zone at the anterior end Cytostome circular, situated at the anterior end of the body, generally an anus at the posterior end One or more contractile vacuoles.

Remarks —This family includes a large number of genera, most of which have been incompletely studied, and it is uncertain if all of them will, on further examination, be found to belong to this family

Genus **BUTSCHLIA** Schuberg, 1888

Bütschlia, Schuberg, 1888, pp 369, *371*, Butschli, *1887–9*, p *1690*, Hickson, 1903, p 400, Wenyon, 1926, pp 1188–9; Reichenow, 1929, p 1171

Body egg-shaped, very minute cilia cover the general surface with a special pre-oral crown of longer cilia, and in some species an additional tuft of longer cilia at the posterior extremity Cytostome terminal, leading to a short pharynx A large spherical macronucleus and a single contractile vacuole present

Three species are known from the stomach of cattle and one from the cæcum of the horse

46 Bütschlia parva Schuberg (Fig 38)

Bütschlia parva, Schuberg, 1888, p 372, pl xii, figs 1 & 2, Wenyon, 1926, p 1189, fig 504, *1*, Reichenow, 1929, p 1171, fig 1158
†*Bütschlia parva,* Kofoid & MacLennan, 1933, p 28

Form oval, often nearly spherical Anterior end almost evenly truncated Cytostome in the middle of the anterior end, leading to a short gullet The entire surface of the body is covered with short and fine cilia, which are arranged in moderately spaced, longitudinal rows, specially long cilia cover the anterior end of the body There is a large spherical macronucleus and a single contractile vacuole The endo-

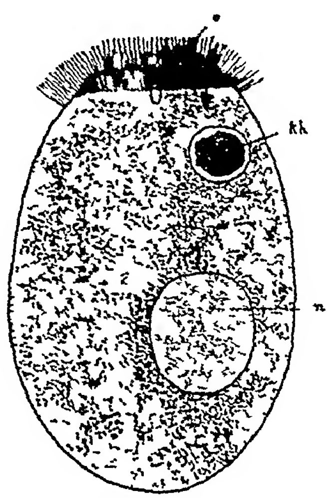


Fig 38—*Bütschlia parva* Schuberg *kk*, excretory mass, *n*, macro nucleus, *o*, mouth Very fine cilia covering the whole body not shown (From Reichenow, after Schuberg)

plasm contains near the anterior end another vacuole, which is filled with strongly refractile, excretory particles Parasitic in the rumen of cattle and sheep

Dimensions—Up to 50 μ in length

Remarks—Schuberg (1888), who first described this species, could detect only the longer cilia covering the anterior end of the body, but later observers state that, in addition, the whole body is covered with fine cilia

Habitat—Stomach of *Bos indicus* locality not noted (Coonoor or Colombo)

2. Tribe PLEUROSTOMATA Schewiakoff, 1896, emend Kahl, 1930.

Gymnostomatous Ciliates with the cytostome slit-like, running from the anterior pole along the compressed ventral border of the body, or round and situated at the base of a proboscis

Identification Table of Families

1 (6)	Cytostome slit like	2
2 (5)	Cytostomial slit ciliated	3
3 (4)	Cytostomial slit on the convex ventral border of the anterior part of the body	[Butsch , p 105. **Amphileptidæ**
4 (3)	Cytostomial slit on the concave ventral border of the anterior part of the body	[p 119 **Loxodidæ** Bütsch ,
5 (2)	Cytostome in an unciliated groove extending backward from the anterior end , near the posterior end is a ciliated groove which may serve as an organ of attachment	[Grandori **Amphibotrellidæ***
6 (1)	Cytostome round, at the base of a proboscis	**Trachelildæ** [Ehrbg , p 115

1. Family AMPHILEPTIDÆ Butschli, 1889

Body lanceolate, more or less laterally compressed, showing two broad lateral surfaces, and dorsal and ventral borders. The ventral border is convex and the dorsal sigmoid Cilia fine, on all sides of the body, or confined to one lateral surface Cytostome slit-like, along the convex ventral border of the anterior part of the body, provided with trichocysts Macronucleus bipartite or quadripartite, rarely undivided and band-shaped

Key to Indian Genera

1 (3)	Both sides of the body normally ciliated	2
2	Oral cleft not reaching to the middle of the body Body without hyaline trichocyst zone Proboscis moderately long	[& Lachm , p 106 AMPHILEPTUS Clap
3 (1)	Only the right side of the body normally ciliated	4
4 (5)	Body ventrally with flat trichocyst zone, dorsally with similar zone or with trichocyst warts, proboscis poorly developed	[p 112 LOXOPHYLLUM Duj ,
5 (4)	Ventral and dorsal borders without trichocyst zone, left side quite unciliated, proboscis well developed	[p 106 LITONOTUS Wrzes ,

Genus AMPHILEPTUS Claparède & Lachmann, 1859

Amphileptus, Claparède & Lachmann 1858–61, p 347, Kent, 1880–2, p 523, Butschli, 1887–9, p 1690, Roux, 1901, p 34, Penard, 1922, p 64, Lepsi, 1926 *a*, p 34, Calkins, 1926, p 405, Schoenichen, 1927, p 189, Reichenow, 1929, p 1172, Kahl, 1930–5, p 182

Body elongated, contractile, only little of the anterior part of the body flattened, posterior part narrower and pointed Cilia fine, thickly arranged on all sides of the body along regular longitudinal rows Cytostome slit-like, along the convex border of the proboscis No cytopharynx Trichocysts often present Locomotion mostly slow, creeping hither and thither, or rotating on the long axis Feeding on animal detritus

47 Amphileptus sp

Amphileptus sp, Simmons, 1891, p 4

Habitat—Pond water BENGAL, Calcutta

Genus LITONOTUS Wrzesniowski, 1870

Amphileptus (part), Ehrenberg, 1838, p 354
Loxophyllum (part), Claparède & Lachmann, 1858–61, pp 357–64
Leionota, Wrzesniowski, 1869, p 33
Litonotus, Wrzesniowski, 1870, p 495
Dileptus (part), Fromentel, 1874, pp 176–7
Litonotus, Kent, 1880–2, p 742
Lionotus, Butschli, 1887–9, p 1691, Roux, 1901, pp 35–6, Penard, 1922, p 64, Lepsi, 1926 *a*, p 35, Calkins, 1926, p 405, Schoenichen, 1927, p 190, Reichenow, 1929, p 1172, Kahl, 1930–5, p 185

Body elongated, strongly flattened, chiefly at the anterior end, often curved in a S-shaped manner, anteriorly drawn out into a more or less elongated neck, posterior end narrow and pointed The right flattened surface with longitudinal rows of cilia, the left side of the body without cilia Mouth slit-like, more or less elongated along the convex border of the anterior portion, with a row of stronger cilia along the left oral border and a row of trichocysts along the right oral border Pharynx absent Contractile vacuole single and terminal, or multiple and arranged in one or two rows Anus at the posterior end or at the base of the tail-like portion. Macronucleus bipartite, the two halves connected by a thread, or sometimes band-shaped or multipartite Body flexible, contractile, often transparent Locomotion slow, gliding on the ciliated side

Remarks—Wrzesniowski erected the genus *Litonotus* for the reception of those species, previously referred to *Loxophyllum* or *Amphileptus*, which he demonstrated to be ciliate only on the lower or " ventral " surface If, however, we regard the edge bearing the slit-like mouth as ventral, the ciliate surface should be referred to as right and the unciliated one as left

Butschli (1889) wrongly changed the name to *Lionotus* with the remark " falslich zuerst Litonotus genannt " The name as given by Wrzesniowski, the author of the genus, is *Litonotus*, and must be followed, as both *Leionota* and *Lionotus* are preoccupied

Key to Indian Species

1 (4)	With single contractile vacuole	2
2 (3)	Lanceolate, macronucleus consisting of two spherical lobes united to one another 80–100 μ in length	*L fasciola* (Ehrbg), [p 107
3 (2)	Lanceolate, macronucleus reniform 90 μ in length	*L infusionus* Ghosh, [p 109
4 (1)	With several contractile vacuoles in a dorsal and a ventral row, posterior end of the body pointed, with trichocysts	5
5 (6)	Macronucleus of two spherical or oval parts, united together by a thread, or discrete 200–300 μ in length	*L pleurosigma* [Stokes, p 110
6 (5)	Macronucleus bilobed, lobes in contact with one another 170 μ in length	*L similis* Ghosh, [p 111

48 **Litonotus fasciola** (Ehrenberg) Wrzesniowski (Fig 39)

Amphileptus fasciola, Ehrenberg, 1838, p 356, pl xxxviii, fig 17, Dujardin, 1841, p 485, pl xi, fig 17

†*Amphileptus fasciola*, Carter, 1856 *b*, p 225

Loxophyllum fasciola, Claparède & Lachmann, 1858–61, pp 361–2

Amphileptus fasciola, Stein, 1867, pp 24, 64, 67, 118, 119

Leionota fasciola, Wrzesniowski, 1869, p 33

Litonotus fasciola, Wrzesniowski, 1870, pp 500–1, pls xxii–xxiii, figs 29–32

Dileptus fasciola, Fromentel, 1874, p 290, pl xviii, fig 8

Litonotus fasciola, Kent, 1880–2, p 743–4, pl xlii, figs 5–11

Amphileptus massiliensis, Gourret & Roeser, 1886, pp 471–2, pl xxix, figs 2, 3

Lionotus fasciola, Butschli, 1887–9, pp 1372, 1388, 1461, 1691, pl lix, fig 6

Loxophyllum fasciola, Maupas, 1888 *a*, p 248, 1889, pp 278–84, pl xvi, figs 29–42

Lionotus fasciola, Schewiakoff, 1889, pp 19–22, 1896, p 202, pl ii, figs 49–50, pl vi, fig 158, pl vii, figs 176, 197, Roux 1901, p 36, pl ii, fig 3

†*Loxophyllum fasciola*, Bhatia, 1920, p 260

†*Lionotus fasciola*, Ghosh, 1921, p 8

Lionotus fasciola, Penard, 1922, p 64, fig 68, Lepsi, 1926 *a*, p 44, fig 99, Schoenichen, 1927, p 190, pl xii, fig 15

Lionotus fasciola, Kahl, 1926, pp 292–3, fig K_1, 1930–5, p 194, fig 28, 7

†*Lionotus fasciola*, Bhatia & Mullick, 1930, p 393

Body lanceolate, flexible but not contractile, the neck-like portion scarcely equalling in length one-half of the entire body, curved at its extremity towards the right, gradually narrowing towards the end, and not sharply distinguished from the body, posterior end obtusely pointed Mouth-cleft along the convex border of the neck, the cilia situated along the mouth-cleft, of larger size than on the remaining surface, trichocysts along the left oral border Contractile vacuole single, situated

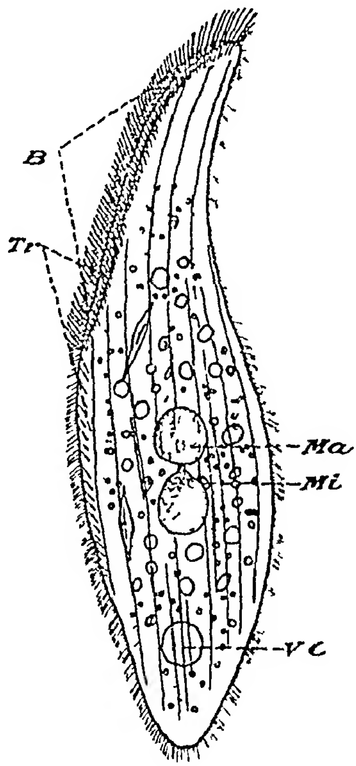


Fig 39 —*Litonotus fasciola* (Ehrbg) *B*, mouth cleft, *Ma*, macro nucleus, *Mi*, micronucleus, *Tr*, trichocysts; *V C*, contractile vacuole (After Roux)

near the base of the short tail-like prolongation Macronucleus bipartite, subcentral, each portion spheroidal, and connected by a cord-like structure, micronucleus between the two portions of the macronucleus Locomotion slow, alternately swimming backwards and forwards

Dimensions —Length 80–100μ

Remarks —Examples of this species were found in large numbers in water from a drain at Lahore They were of

somewhat smaller size than usual, and measured 94 μ by 31 μ, the neck portion being 31 μ, i e, one-third of the entire length Locomotion was characteristic, slowly swimming forwards or backwards Very much smaller specimens were found in pond water at Srinagar (Kashmir)

Habitat—Dirty water KASHMIR, Srinagar, PUNJAB, Lahore, BOMBAY, BENGAL, Calcutta

49 **Litonotus infusionus** Ghosh (Fig 40)

†*Lionotus infusionus*, Ghosh, 1920 *a*, pp 146–7, fig 3, 1921 *a*, p 7
Lionotus infusionus, Kahl, 1930–5, p 195

Body lanceolate, widest in the middle and tapering to a rounded end posteriorly Dorsal surface strongly convex in the middle, ventral slightly so, with a median ridge extending from the middle of the body to the posterior end Anterior beak twisted and bent to the left side and towards the ventral

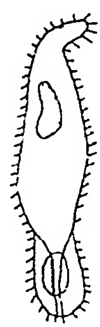


Fig 40—*Litonotus infusionus* Ghosh (After Ghosh)

aspect Cytostome slit-like, occupying about one-third the body-length Cilia in longitudinal meridional rows, those along the left margin of the cytostome longer than the others Trichocysts usually in a row along the right margin of the beak Contractile vacuole single, large, oval and postero-terminal Macronucleus reniform, placed obliquely in the anterior half of the body Micronucleus small, spherical, in the notch of the macronucleus

Dimensions—Length 90 μ, width 20 μ

Habitat—Hay infusions and pond water among *Epistylis* and *Carchesium* colonies BENGAL, Calcutta

50 **Litonotus pleurosigma** Stokes (Fig 41)

Litonotus pleurosigma, Stokes, 1884 *b*, p 124
†*Loxophyllum fasciola* subsp *punjabensis* Bhatia, 1916, pp 181–2, fig 3
Lionotus pleurosigma, Penard, 1922, pp 68–9, fig 74
Hemiophrys (*Lionotus*) *pleurosigma*, Kahl, 1926, pp 293–5, fig L_1, 1930–5, p 186–7, fig 28, 3

Body elongate, transparent, flexible, but scarcely contractile, posterior end drawn out into a tail-like prolongation or only pointed, tapering gradually towards the anterior extremity, which is curved Oral cleft along the convex border Cuticular surface longitudinally striate, cilia more conspicuous on the neck-region Contractile vacuoles multiple, variable in number, arranged in two rows Macronucleus bipartite, spheroidal,

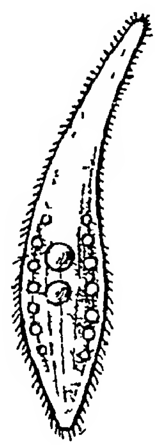


Fig 41 —*Litonotus pleurosigma* Stokes *C V*, contractile vacuoles *N* macronucleus (After Bhatia)

subcentral, micronucleus between the two parts of the macronucleus

Dimensions —Length up to 300μ

Remarks —The animal showed slow locomotion, now moving forwards, then suddenly in a backwards direction The length of a specimen was 147μ and the maximum width 42μ When I made the acquaintance of this form I did not have Stokes's work at my disposal, and it appeared to resemble most closely *Litonotus varsoviensis* Wrz (Kent, 1880–2, p 744, pl xlii, fig 4), from which, however, it differed in the number of contractile vacuole asnd their arrangement in two longitudinal rows instead of one containing five contractile vacuoles only At the time I considered that both my form and

L varsoviensis should be regarded as distinct subspecies of *L fasciola*, which some writers had removed from the genus *Litonotus*, reserved for species with a very long neck (in some being even longer than the body), and had again placed in *Loxophyllum*, to which indeed it originally belonged the name *punjabensis* was given to the subspecies to indicate its special peculiarities

Recent workers have, however, more accurately defined *Litonotus*, and *L fasciola* has again been placed under that genus by Roux, Penard and others, and Kahl, in his recent monograph, has referred my form to *Litonotus pleurosigma* Stokes, a view which I accept Kahl states that the neck often possesses an apical group of trichocysts, and the trichocysts are also distributed in the plasma The trichocysts were not noticed by me

Habitat —Stagnant water PUNJAB, Lahore

51 **Litonotus similis** Ghosh (Fig 42)

†*Lionotus similis*, Ghosh, 1921 *a*, p 8, fig 3
Hemiophrys (*Lionotus*) *similis*, Kahl, 1930–5, p 188

Body broadly lanceolate, widest behind the middle, more tapering anteriorly than posteriorly Anterior end pointed

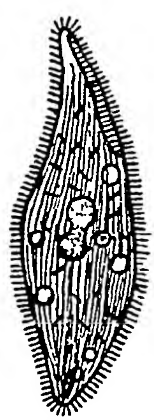


Fig 42 —*Litonotus similis* Ghosh

and curved to one side Cytostome extending beyond the anterior one-third of the length of the body Longitudinal ciliary rows faint Trichocysts scattered Contractile vacuoles 5–6 in number and placed in two rows along both the margins Micronucleus by the side of the macronucleus

Dimensions —Length 170μ, width 52μ

Remarks —According to Ghosh this species differs from *L fasciola* Ehrbg in having scattered trichocysts, a smaller cytostome, and numerous contractile vacuoles, but agrees with it in having a bilobed macronucleus It resembles *L diaphanes* Wrzesn in having scattered trichocysts, but differs from it in the arrangement of the contractile vacuoles and in the shape of the macronucleus Kahl (1930) thinks that it is probably identical with *L pleurosigma* The macronucleus does not, however, consist of two discrete parts, and the contractile vacuoles, though stated to be 5–6 in two rows, are actually shown in the figure as 4 in the ventral and 2 in the dorsal row

Habitat —Vegetable infusions BENGAL, Calcutta

52 **Litonotus** sp

Lionotus sp, Chaudhuri, 1929, p 54

Habitat —Soils from CENTRAL INDIA, Indore, and CEYLON, Colombo

Genus LOXOPHYLLUM (Dujardin, 1841), emend Wrzesniowski, 1869

Loxophyllum (part), Dujardin, 1841, pp 467, 487, (part) Claparède & Lachmann, 1858–61, pp 357–64

Loxophyllum, Fromentel, 1874, p 178, Kent, 1880–2, pp 527–8, Butschli, 1887–9, p 1692, Roux, 1901, p 38, Penard, 1922, p 71, Lepsi, 1926*a*, p 35, Calkins, 1926, p 405, Schoenichen, 1927, p 191, Reichenow, 1929, p 1172, Kahl, 1930–5, pp 195, 197

Body contractile and flexible, flattened, leaf-like, pointed at the anterior and posterior ends Anterior portion bent towards the dorsal border Cilia in longitudinal rows on the right surface of the body, left surface without cilia Mouth slit-like, along the convex border of the anterior portion, as in the preceding genus Recognizable from the preceding genus by the possession of a hyaline zone along the ventral border, extending up to the posterior end and usually provided with trichocysts, with a similar zone extending along the dorsal border, or narrow and with trichocysts collected in warty bundles Locomotion gliding

Key to Indian Species

Body small, up to 250 μ Macronucleus bipartite	[p 113 *L helus* (Stokes),
Body large, up to 700 μ Macronucleus multipartite or rosary shaped	[Mull), p 114 *L meleagris* (O F

53 Loxophyllum helus (Stokes) (Fig 43)

Litonotus helus, Stokes, 1884, p 124, 1888, p 268, pl ix, fig 19
Loxophyllum helus, Penard, 1922, p 73, fig 78, Kahl, 1926, pp 295–6, fig M_1, 1930–5, pp 199–200, fig 30, *17*
†*Loxophyllum helus*, Bhatia & Mullick, 1930, p 393

Body elongate, lanceolate, flattened, anterior end prolonged into a short neck which is curved towards the dorsal edge, posterior end acuminate, very contractile Mouth slit-like along the convex border of the neck Hyaline zone narrow, provided with fine trichocysts along the ventral border and the posterior end The dorsal border is raised into a number

Fig 43

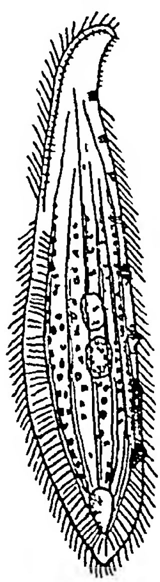


Fig 44

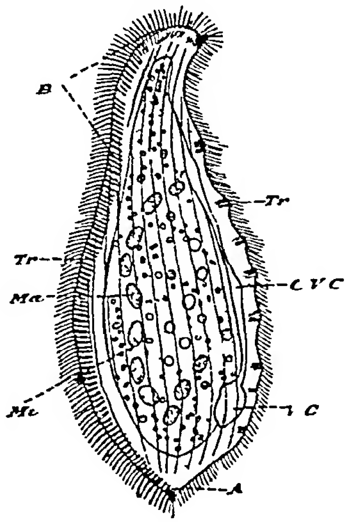


Fig 43 —*Loxophyllum helus* (Stokes) (After Kahl)
Fig 44 —*Loxophyllum meleagris* (O F Müll) *A*, anus, *B*, cytostome, *C V C*, feeder canal of the vacuole, *Ma*, macronucleus, *Mi*, micronucleus, *Tr*, trichocysts, *V C*, contractile vacuole (After Roux)

of papillæ, underneath each of which is a bundle of trichocysts The right side of the body is flattened and covered over by cilia arranged along numerous closely approaching longitudinal lines The left side is bulging and marked by only a few furrows, but does not bear any cilia Contractile vacuole posterior, subterminal, sometimes with accessory vacuoles Macronucleus consists of two ellipsoid portions with a micronucleus lying between them

Dimensions—Length 109–130μ, and up to 250μ when fully extended

Remarks—A few specimens, showing the characters of the species as given above, were met with The length of the organisms was only 124μ Scarce

Habitat—Pond water KASHMIR, Srinagar

54 Loxophyllum meleagris (O F Muller) (Fig 44)

Kolpoda meleagris, O F Müller, 1786, pp 99–101, pl xiv, figs 1–6, pl xv, figs 1–5

Amphileptus meleagris, Ehrenberg, 1838, p 357, pl xxxviii, fig 4

Loxophyllum meleagris, Dujardin, 1841, pp 488–9, pl xiv, fig 6, Claparède & Lachmann, 1858–61, pp 358–61, pl xvi, fig 9, Stein, 1859 *d*, pp 61–3, 89, 1867, pp 10, 64, 67, 80, 81, 82, 90, 104, Pritchard 1861, p 639, Wrzesniowski, 1869, pp 44–5, 48, pl iv, figs 28–30, Fromentel, 1874, p 294, pl xx, fig 7, Kent, 1880–2, p 528, pl xxvii, fig 52, Bütschli, 1887–9, p 1692, pl lx, fig 2, *a*, *b*, Schewiakoff, 1896, p 209, pl iii, fig 55, Roux, 1901, p 38, pl ii, fig 8, Penard, 1922, pp 71–3, fig 77

†*Loxophyllum meleagris*, Gulati, 1925, p 747, pl i, fig 8

Loxophyllum meleagris, Lepsi, 1926 *a*, p 43, fig 105, Calkins, 1926, p 380, fig 167, Schoenichen, 1927, p 192, fig 719, Kahl, 1930–5, p 202 fig 30, *12*

Body very flexible Form very variable, from lanceolate to broadly leaf-shaped, narrow anteriorly and curved towards the dorsal aspect Ventral border broad, uniformly provided with trichocysts Dorsal border crenulate, the projections provided with groups of trichocysts Contractile vacuole single, dorsal, subterminal, with a distinct canal running near the dorsal border and presenting several ampullæ Ciliary lines close, with short, thick cilia Macronucleus rosary-shaped or consisting of separate small oval masses Micronuclei corresponding in number to the parts of the macronucleus

Dimensions—Length 300–400μ, sometimes much larger, up to 700μ (according to Penard)

Habitat—Stagnant water PUNJAB, Lahore

2 Family TRACHELIIDÆ Ehrenberg, 1840

Elongated or ovoid or almost spheroid forms, provided with a short or long proboscis Body covered with uniform cilia Special cilia along the ventral border of the trunk Cytostome round, situated at the base of the proboscis Cytopharynx provided with trichocysts or trichites Contractile vacuoles numerous Macronucleus multipartite or band-shaped

Key to Indian Genera

1		Anterior end of the body runs out into a trunk or finger-like process Free-living	2
2	(3)	Form lanceolate, posteriorly drawn out into a tail-like process or at least pointed, rounded only in a form found in moss	[p 115 DILEPTUS Duj ,
3	(2)	Form oval to spherical, posteriorly rounded or only slightly pointed	[p 117 TRACHELIUS Schr ,

Genus DILEPTUS (Dujardin, 1841), emend Wrzesniowski, 1870

Dileptus, Dujardin, 1840, p 285 , 1841, pp 404–7
Amphileptus (part), Claparede & Lachmann, 1858–61, pp 347–8, Fromentel, 1874, p 176 , Kent, 1880–2, p 523
Dileptus, Butschli, 1887–9, p 1693 , Schewiakoff, 1896, p 219 , Roux, 1901, p 41 , Penard, 1922, p 79 , Lepsi, 1926 *a*, p 35 , Calkins, 1926, p 405 , Schoenichen, 1927, p 192 , Reichenow, 1929, p 1172 , Kahl, 1930–5, pp 204–5

Animalcules free-swimming, medium sized to very large Body not compressed, greatly elongated and very contractile , posterior end usually tapering , neck long, very movable, more or less bent dorsalwards Mouth a round opening situated at the base of the neck Cilia on all sides fine, with a row of stronger cilia along the ventral border of the proboscis Along the ventral border of the proboscis is a row of trichocysts, which are also found in the upper surface of the body Contractile vacuoles numerous, in several rows along the back Anal aperture situated at the base of the pointed tail Macronucleus elongated, band-shaped or rosary-shaped , micronuclei numerous and lying close to the parts of the macronucleus Locomotion quick and graceful, the neck constantly bending forwards and backwards Fresh water and marine

55 **Dileptus anser** (O F Muller) (Fig 45)

Vibrio anser, O F Muller, 1773, p 46, 1786, pp 73–4, pl x, figs 7–11
Amphileptus anser, Ehrenberg, 1838, p 355, pl xxxviii, fig 4
Amphileptus margaritifer, Ehrenberg, 1838, p 355, pl xxxvii, fig 5
Dileptus anser, Dujardin, 1841, pp 407–9, pl vii, fig 17
Amphileptus anser, Claparède & Lachmann, 1858–61, p 352
Dileptus anser, Stein, 1859*d*, pp 61–4, 80, 81, 90, 1867, pp. 67, 75, 81, 82
Amphileptus anser, Pritchard, 1861, p 636, pl xxiv, figs 312–13, Fromentel, 1874, p 286, pl xviii, figs 9, 9 *a*, Kent, 1880–2, p 525, pl xxvii, figs 39 & 40
Dileptus anser, Butschli, 1887–9, p 1693, pl lix, fig 4, *a–g*, Schewiakoff, 1889, pp 22–4, pl iii, figs 31–3, 1896, pp 221–2, pl iii, fig 61, pl vii, fig 181, Roux, 1901, p 42, pl ii, fig 11
†*Dileptus gigas*, Bhatia, 1922, p 29
Dileptus anser, Lepsi, 1926*a*, p 44, fig 113, Calkins, 1926, pp 61, 116, figs 24, 58
Dileptus gigas, Schoenichen, 1927, p 192, pl xii, fig 17
Dileptus anser, Kahl, 1930–5, p 205, fig 31, *17*

Body elongated, brownish-yellow or greyish-white, posterior end with a pointed tail-like projection, the neck more or less

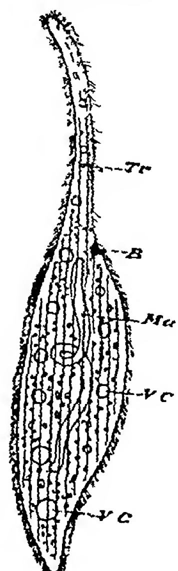


Fig 45.—*Dileptus anser* (O F Mull) *B*, cytostome, *Ma*, macro nucleus, *Tr*, trichocysts, *V C*, contractile vacuoles (After Roux)

elongated, strongly compressed, one-half to as long as the body Cilia of the body short, fine, with stronger adoral cilia on the ventral border of the proboscis Mouth at the base of the neck surrounded by a swollen margin without cilia

Cytopharynx funnel-shaped, longitudinally striated Tricho-cysts on the ventral surface of the neck Contractile vacuoles numerous, in a dorsal row Anal aperture on the surface at the base of the tail Macronucleus elongated, sausage-shaped or moniliform Very voracious, devouring large animalcules

Dimensions—Length 200–400μ, rarely up to 600μ

Remarks—The body and the neck showed movements which are characteristic of the species Specimens were smaller than the size usually recorded for the species they measured on an average 200μ only The ratio between the length of the neck and that of the rest of the body in the specimens that came under my observation was 2 to 3 The cilia covering the body were very fine and close-set, and the neck showed a narrow groove along which the stronger adoral cilia were situated The body did not show any longitudinal striations, and the endoplasm was finely granular The row of contractile vacuoles extended into the proboscis also The tail was obtusely pointed, and not drawn out into a distinct prolongation

The original descriptions of *D anser* and *D gigas* were not available to me in 1922, and, the two species having been merged into one by Eyferth-Schoenichen (1909), I referred my examples to *D gigas* Schoenichen (1927) still regards the two as synonyms Kahl (1930–5) has stated the distinctions clearly, and the form is now correctly referred to *D anser*

Habitat—River water PUNJAB, Lahore

Genus **TRACHELIUS**, Schrank, 1803, emend. Claparède & Lachmann, 1858–61

Trachelius, Schrank, 1803, p 20

Trachelius (part), Ehrenberg, 1838, p 320

Trachelius, Claparède & Lachmann, 1858–61, pp 345–7, Fromentel, 1874, p 182, Kent, 1880–2, p 522, Butschli, 1887–9, p 1692, Schewiakoff, 1896, p 216, Roux, 1901, p 41, Hickson, 1903, p 400, Minchin, 1912, p 439, Penard, 1922, p 80, Calkins, 1926, p 405, Lepsi, 1926 *a*, p 35, Schoenichen, 1927, p 192, Reichenow, 1929, p 1172, Kahl, 1930-5, p 210

Body elongated oval or spherical, with rounded posterior end and relatively short and plump neck, which is curved dorsal-wards Body flexible, neck mobile Endoplasm wide-meshed Ventral surface flattened, sometimes with a depression in its middle Mouth on ventral surface at the base of the neck Cilia uniform on all sides A row of stronger cilia extends back from the anterior extremity of the neck, surrounds the mouth and is continued forward again to the anterior extremity Cytopharynx long, conical, provided with

rods Anus posterior, ventral Contractile vacuoles numerous Macronucleus central, ovoid Micronucleus close by. Movements swift, rotating round the long axis Feeding on diatoms, algæ and infusoria

56 **Trachelius gutta** (Cohn) (Fig 46)

Amphileptus gutta, Cohn, 1866, p 269, pl xv, fig 50, Kent, 1880–2 p 527
Trachelius gutta Hamburger & Bruddenbrock, 1911 pp 33–4, fig 29
?*Trachelina gutta*, Ghosh 1920 *a*, pp 144–5, fig 1, 1921 *a*, p 8
Trachelius gutta, Lepsi, 1926*a*, p 44

Body elongate-pyriform, rounded and widest posteriorly, anterior extremity pointed, curved towards the dorsal aspect Cytostome situated on the ventral surface at a distance of

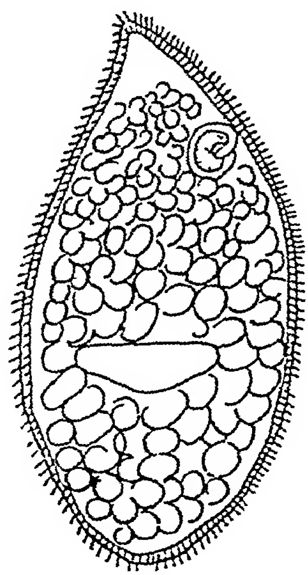


Fig 46 —*Trachelius gutta* (Cohn) (After Ghosh)

about one-third of the length of the body from the anterior extremity Cytopharynx a smooth, conical, corneous tube, with its long axis in the direction of the curvature of the neck Cuticular surface striate longitudinally, densely clothed with short, fine, even cilia, cilia on the anterior or oral regions not specially differentiated Endoplasm with numerous large, spherical water-vacuoles Contractile vacuole single, postero terminal Macronucleus in the form of numerous scattered,

refringent corpuscles Locomotion constant in a forward direction, rotating on its long axis.

Dimensions —Length 120–125 μ

Remarks —The form described by Ghosh (1920 *a*) differs from the description, as given above, in the following respects — The cytostome is at one-fourth of the length of the body from the anterior end, contractile vacuoles are two in number, macronucleus is irregularly and elongately oval and placed in the posterior half of the body, anterior portion forms a broad proboscis and is devoid of spherical granules Length 214 μ, breadth 101 μ Organism is capable of changing its shape from an elongated pyriform to a nearly spherical form Ghosh considers it to be a new variety of *T gutta*, but from his description and figure it is impossible to decide if the form has been correctly identified

Habitat.—Putrefying vegetable infusions BENGAL, Calcutta

3 Family LOXODIDÆ Butschli, 1889.

Body elongated, more or less laterally flattened, anteriorly terminating in a beak-like process which is curved ventralwards, posteriorly pointed or rounded Cilia rather long, distributed along longitudinal lines, on the right surface of the body only The dorsal and ventral borders bear numerous, short, immobile, tactile bristles Cytostome slit-like, situated on the concave ventral border of the anterior part of the body Contractile vacuole absent or single Macronuclei two or more

This family contains only one genus

Genus **LOXODES** Ehrenberg, 1830, emend Claparède & Lachmann, 1858

Loxodes, Ehrenberg, 1830, p 42, 1838, p 323, Claparède & Lachmann, 1858–61, p 339

Drepanostoma, Engelmann, 1862, p 382

Loxodes, Fromentel, 1874, p 182, Kent, 1880–2, p 748, Butschli, 1887–9, p 1694, Schewiakoff, 1896, p 212 Roux, 1901, p 39, Minchin, 1912, pp 439, 448, Penard, 1922, p 77, Calkins, 1926, p 405, Lepsi, 1926 *a*, p 35, Schoenichen 1927, p 193, Reichenow, 1929, p 1172, Kahl, 1930–5, p 212

Large to very large, elastic but persistent in form, flattened and leaf-like, anteriorly with a beak bent ventralwards, posterior end pointed or rounded The right surface is slightly convex, distinctly longitudinally striated and ciliated, the cilia being delicate, moderately long, and closely arranged in longitudinal

rows, the left surface is flat and naked* The ectoplasm appears to be more or less brown, owing to closely situated brown granules Along the dorsal border lie a variable number (5–25) of strongly refractile bodies known as Muller's corpuscles In the ventral border of the beak is a narrow cleft, the cytostome extending as a slit along the whole curvature of the blade of the sickle which characterizes the anterior part of the animal, there is no true cytopharynx (what is generally represented as cytopharynx and looks like the handle of the sickle is merely an internal fold) The endoplasm is vacuolated Contractile vacuole absent or single A row of non-contractile vesicles may also be present Anus situated on the unciliated surface in the posterior quarter of the body The macronuclei are two in number or numerous, small and spherical, each with a strong membrane and a central nucleolus, and arranged along the length of the animal in a more or less regular row, the micronuclei are in the neighbourhood of the macronuclei Locomotion moderately quick

Key to Indian Species

1 (6) Two macronuclei 2

2 (3) The macronuclei lie so close to one another that the single micronucleus is flattened between the two

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* Great divergencies are met with in the recorded descriptions by different authors of the various forms included in this genus In the first place, it may be pointed out that all the German authors speak of the borders as being ventral and dorsal and the flattened and convex surfaces as right and left respectively, while English, French and American writers refer to the borders as being situated on the left and right and the two surfaces as ventral and dorsal As regards the nuclei, Wrzesniowski has demonstrated "a racemose development of the numerous spherical endoplasts or nuclei, with their attached endoplastules In many instances the endoplastule, instead of being fixed to the endoplast, is found attached separately to the cord or funiculus while in other cases it may be entirely absent" (Kent, 1880–2, p 749, and pl i, fig 14) Bütschli, in his description of the genus, states "Ein bis sehr zahlreiche kleine runde Ma Ni (je nach der Grosse der Thiere) durch den gresammten Korper zerstreut und unverbunden Zahl der Mi Ni ähnlich verschieden" Schewiakoff (1893) remarks as follows —"Unterscheidet sich von den bisher unter diesem Namen beschriebenen Formen durch einen ovalen, in der Korpermitte gelegnen, fein netzigen *Makronucleus*, dem ein kleiner mikronucleus anliegt und durch die Lage der contractilen vacuole Letztere liegt nicht terminal, sondern rechtseiting in der vorderen Korperhälfte unweit des Mundendes Diese Unterschiede halte ich fur unzureichend zur Aufstellung einer neuen Art" Conn (1918) states "Nuclei may be two or more" Penard (1922) says that nuclei are numerous, small and spherical There would thus seem to be at least three distinct types of nuclear apparatus (1) a single macro nucleus as described by Schewiakoff, (2) two macronuclei as described by Conn, and (3) numerous macronuclei, either connected by a thread or not, as described by Wrzesniowski, Bütschli and the present writer

3 (2)	The macronuclei lie wide apart	4
4 (5)	Two micronuclei, attached to the posterior pole of the anterior and the anterior pole of the posterior macronucleus, posterior end of the body pointed ventralwards, no contractile vacuole length up to 200 μ	*L striatus* (Engelmann), p 123
5 (4)	Two micronuclei lying close behind each macronucleus, posterior end rounded, contractile vacuole postero terminal length 130–170 μ	*L bahaduri* Bhatia & Mullick, p 121
6 (1)	Macronuclei and micronuclei numerous	7
7	Posterior end of the body more or less pointed ventralward, contractile vacuole single, central, with a row of non-contractile vesicles arranged along the ventral border	*L punjabensis*, sp nov, p 121

57 Loxodes bahaduri Bhatia & Mullick (Fig 47)

†*Loxodes bahaduri*, Bhatia & Mullick, 1930, p 392, fig 1

Body elongated and laterally compressed, elastic, though preserving a definite oval shape The anterior end pointed and curved towards the ventral border The ventral border of the anterior portion marked by a groove, at the bottom of which the cytostome is situated Cytopharynx absent The borders are uniformly ciliated Cytoplasm colourless and more or less vacuolated Contractile vacuole single, postero-terminal, and a few small non-contractile vesicles arranged along the dorsal border Two spherical macronuclei with micronucleus lying close behind each

Dimensions—Length from 130 to 170 μ

Remarks—This species has some resemblance to *L magnus* Stokes (as described by Kahl), from which it differs, however, by its smaller size, proportionately narrower body, number and structure of the macronuclei and the possession of a definite contractile vacuole, which was observed to contract after long intervals The dimensions of *L magnus* are given as 400–600 μ, but our specimens did not exceed 170 μ

Habitat—Pond water KASHMIR, Srinagar

58 Loxodes punjabensis, sp nov (Fig 48)

†*Loxodes rostrum*, Bhatia (not O F Müll), 1920, p 260

Body flexible, flattened, highly vacuolated, the anterior extremity curved slightly ventralwards and terminating in a beak-like projection, along the ventral border of the beak is a slit-like cytostome, cytopharynx absent, the posterior extremity is also bent slightly in the same direction as the anterior end Contractile vacuole single with a row of much

smaller non-contractile vacuoles along one border of the body Macronuclei many, with laterally attached micronuclei Animalcules swim evenly or rotate on their axis and creep over foreign objects

Dimensions —Length up to 150 μ

Remarks —Specimens found at Lahore were originally wrongly referred to *Loxodes rostrum* *Loxodes rostrum* (O F Muller) is shown by Roux as possessing numerous macronuclei

Fig 47

Fig 48

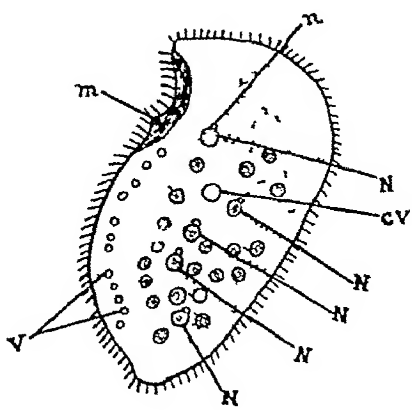


Fig 49

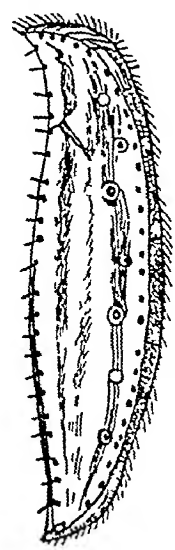


Fig 47 —*Loxodes bahaduri* Bh & M (After Bhatia and Mullick)

Fig 48 —*Loxodes punjabensis*, sp nov *c v*, contractile vacuole, *m*, cytostome, *N*, macronuclei, *n*, micronucleus, *V*, non contractile vacuoles

Fig 49 —*Loxodes striatus* (Engelm) Two somewhat larger spherical bodies are macronuclei, and the other five are statoblasts (After Kahl)

and by Kahl as possessing only two macronuclei with a micro nucleus situated between them Kahl's description and figure of *Loxodes magnus* Stokes resemble very closely those given by Roux for *L rostrum*, and he thinks this form has been wrongly designated as *L rostrum* by other authors as well

My form differs from *L rostrum* (O F Mull) (as described by Kahl) in possessing many macronuclei, one contractile and many non-contractile vacuoles, and in the absence of the cyto-pharynx and the marginal setæ It shows some resemblance to *L magnus* Stokes (as described by Kahl), but differs from it in (1) a smaller size and greater proportional width, (2) the presence of a single contractile and a number of non-contractile vacuoles, and (3) the absence of cytopharynx and the marginal setæ The size of *L magnus* is stated to be 400–600μ My specimens measured 126–150μ in length and 44–63μ in width. Kahl (1930–5) has enumerated and distinguished in this genus four species and two new varieties of *L magnus* The present form differs from them all it is, therefore, now recognized as a distinct species

In the forms that came under my observation the body was flexible, but persistent in form and flattened In addition to the characters noted above, the marginal cilia were short, fine and close-set, and there were no marginal setæ or spines The cilia bordering the adoral groove were somewhat larger than the marginal cilia The cytostome measured 32μ in one specimen and 42μ in another—that is, about one-fourth of the entire length of the body The surface of the body did not show any longitudinal striations, but the deeper layer was longitudinally furrowed The endoplasm was granular and vacuolated, and numerous chloroplasts were scattered in it, the colour of the part of the body that was free from them was greyish

The single contractile vacuole was situated about the middle of the body, and numerous, very much smaller non-contractile vesicles were arranged in a row along the ventral border

The macronuclei were spherical, of the vesicular type, irregularly distributed in the posterior three-fourths of the body, and were not connected by any cord-like filament or funiculus The micronuclei were not detected

Habitat —Pond water PUNJAB, Lahore

59 **Loxodes striatus** (Engelmann) (Fig 49)

Drepanostoma striatum, Engelmann, 1862, pp 382–3, pl xxxi, fig 7

Loxodes striatus, Penard, 1917, pp 471–6, figs 5–12, 1922, p 79, fig 83

†*Loxodes striatus*, Bhatia & Mullick, 1930, pp 392–3

Loxodes (Drepanostoma) striatus, Kahl, 1930–5, p 215, fig 33, *3*

Body elongated, lanceolate and colourless or brownish flexible, with its right surface slightly convex and marked with longitudinal lines, along which very fine cilia are evenly

distributed, the left surface is flattened and naked Anterior end curved towards the ventral border. Cytostome cleft-like along the curved anterior part Along the dorsal border 4 to 6 statoblasts are described by Penard No contractile vacuole Two spherical macronuclei, each provided with a strong nuclear membrane and a large centrally placed nucleolus Two micronuclei are placed close to the nuclear membrane, attached to the posterior pole of the anterior and the anterior pole of the posterior macronucleus

Dimensions —Length up to 250 μ

Remarks —The statoblasts described by Penard were not noticed, though a few non-contractile vacuoles were present along the dorsal border The stiff tactile bristles described as occurring along the ventral border were also not present The length of our specimens varied from 142 to 190 μ

Habitat —Pond water KASHMIR, Srinagar

60 **Loxodes** sp

Loxodes sp, Simmons, 1891, p 4

Habitat —Pond water BENGAL, Calcutta.

3. Tribe HYPOSTOMATA Schewiakoff, 1896, emend Kahl, 1931.

Gymnostomatous Ciliates in which the cytostome lies in the anterior half of the flattened ventral surface, the cytopharynx usually provided with a rod-apparatus

Identification Table of Families

1 (2)	Ciliation complete, the dorsal surface may be somewhat more sparsely ciliated than the ventral	[p 125 **Nassulidæ** Butsch,
2 (1)	Ciliation incomplete, cilia absent from the dorsal surface, at the most only a few bristles present	3
3 (6)	Free living forms	4
4 (5)	No style from the posterior end of the ventral side	[Claus, p 131 **Chlamydodontidæ**
5 (4)	A style arising from the posterior end of the ventral surface	[& Lachm **Dysteriidæ** * Clap
6 (3)	Parasitic forms on Amphipods and Isopods, enclosed in an imperforate shell, the form segments into a number of tomites which escape and show a type of ciliature different from the trophont	[Chat & Lw **Pilisuctoridæ** *

1. Family NASSULIDÆ Bütschli, 1889

Body ciliated all over, the dorsal surface may be somewhat more sparsely ciliated than the ventral. Cytostome situated in the anterior half of the flattened ventral surface. Cytopharynx almost always provided with a rod-apparatus.

Key to Indian Genera

1 (2)	The opening of the rod-apparatus lies deep at the base of an outer portion, the outer opening of which is narrowed by a second membrane	NASSULA Ehrgb., [p. 125
2 (1)	The opening of the rod apparatus lies in the upper surface or at the bottom of a flat depression, not opening to the outside .	3
3 (4)	The rod-apparatus opens in a strong depression, the anterior margin of which bears a membranous structure of cilia. Slender, oval, more or less flattened, small Infusoria, sometimes with striking trichocyst layer	CYCLOGRAMMA Perty, [p. 128.
4 (3)	The rod apparatus opens without a distinct depression in the surface. Mostly distinctly flattened, without trichocysts	5
5 (6)	The left margin of the body shows anteriorly no beak-like structure or a very weakly developed one. Opening of the rod-apparatus median	CHILODONTOPSIS [Blochm., p. 129
6 (5)	The left margin of the body shows a distinct projecting beak-like structure in the neighbourhood of the mouth. The opening of the rod apparatus directed to the right	ORTHODONELLA [Bhatia, p. 130

Genus **NASSULA** Ehrenberg, 1833

Nassula, Ehrenberg, 1833, p. 303; 1838, p. 338; Dujardin, 1841, p. 494.
Liosiphon, Ehrenberg, 1853, pp. 186, 193.
Nassula, Claparède & Lachmann, 1858–61, p. 324; Fromentel, 1874, p. 168; Kent, 1880–2, p. 494; Bütschli, 1887–9, p. 1694; Roux, 1901, p. 42; Hickson, 1903, pp. 397, 400; Minchin, 1912, p. 430; Penard, 1922, p. 85; Lepsi, 1926*a*, p. 36; Calkins, 1926, p. 404; Wenyon, 1926, p. 1175; Schoenichen, 1927, p. 194; Reichenow, 1929, p. 1173; Kahl, 1930–5, p. 216.

Animacules of medium size to very large. Body flexible and contractile, generally egg-shaped to elongated, mostly with distinctly flattened ventral and strongly bulging dorsal side, with both the anterior and the posterior ends rounded.

Cytostome situated on the ventral surface of the body at some distance from the anterior end From the cytostome a row of strong cirri usually extends to the back along a depression of the body lying on the left side Cilia uniform Body striations faint and weakly spiral Cytopharynx provided with well-developed rod-apparatus, the opening of the tubular rod-apparatus lies at the base of an outer portion, the outer opening of which is narrowed by a second membrane Anal aperture always terminal Contractile vacuoles one or more, when single usually in the middle region of the body, sometimes, however, up to four in number, lying partly on the dorsal and partly on the ventral side Often with a complex covering of trichocysts Macronucleus mostly spherical and central, rarely band-shaped, with one or more micronuclei lying close by The body is sometimes colourless, mostly, however, it is red, blue or brown Feeds on *Oscillaria* and Diatoms, and the body is consequently found to contain red, blue or violet food-vacuoles Cysts spherical Locomotion uniform and constant

Key to Indian Species

1 Body oval, without a flexible anterior prolongation, cytopharynx without rod apparatus, contractile vacuole central — *N ambigua* St, [p 126

2 Body ovate, with a flexible anterior prolongation, cytopharynx with a rod apparatus, contractile vacuole posterior — *N stramphii* (Ehrbg), p 127

61 **Nassula ambigua** Stein (Fig 50)

Nassula ambigua, Stein, 1854, pp 248–9, pl vi, figs 42–4
Liosiphon ambiguus, Stein, 1859 *d*, p 72, fig 88
Nassula ambigua, Claparède & Lachmann, 1858–61, p 329, Kent, 1880–2, p 495, pl xxvi, fig 41, Schewiakoff, 1896, p 236
†*Nassula ambigua*, Gulati, 1925, p 748, pl i, fig 10
Nassula ambigua, Lepsi, 1926 *a*, p 44, fig 116, Schoenichen, 1927, p 195, fig 722, Kahl, 1930–5, p 220

Body oval, rounded at both extremities, about one and a half times as long as broad, evenly ciliate, beautifully coloured with red and green particles Cytopharynx a horny tube, ciliated anteriorly, and without rod-apparatus Contractile vacuole single, spherical, central Macronucleus rounded or oval

Dimensions—Up to 160μ in length

Remarks—Gulati, who described this species from Lahore, gives the size as 80μ by 50μ and shows the macronucleus as rounded

Habitat—Pools PUNJAB, Lahore

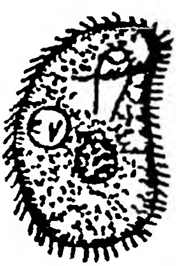
62 **Nassula stramphii** (Ehrenberg) (Fig 51)

Liosiphon stramphii Ehrenberg, 1853, pp 184–6, 193
Nassula stromphii Kent, 1880–2, p 496
†*Nassula stromphii* Bhatia, 1916, p 182

Body ovate, with a distinct large prolongation of the anterior region beyond the cytostome, anterior portion flexible, colour green owing to the ingestion of algæ as food-particles Cilia uniform Cytopharynx tubular, with a cylindrical fascicle of rod-like teeth Contractile vacuole large, posteriorly situated, with pinkish contents*, with two or more smaller vacuoles irregularly distributed Macronucleus oval, sub central and eccentric

Fig 51

Fig 50



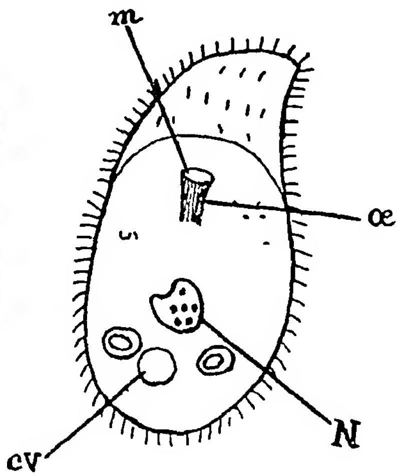


Fig 52

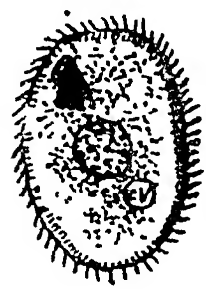


Fig 50 —*Nassula ambigua* Stein (After Gulati)
Fig 51 —*Nassula stramphii* (Ehrbg) *c v*, contractile vacuole, *m* cytostome, *N*, nucleus, *œ*, cytopharynx (After Bhatia)
Fig 52 —*Cyclogramma rubens* Perty (After Gulati)

Dimensions —Length 57 μ, width 36 μ

Remarks —The row of stronger cirri, extending from the mouth and so characteristic of the other species of the genus is absent in this form

Habitat —Ditch water PUNJAB, Lahore

63 **Nassula sp.**

†*Nassula* sp Carter, 1855

Habitat —Fresh water Bombay.

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* The pink tinge is probably apparent rather than real, and is a contrast effect of the green body

Genus **CYCLOGRAMMA** Perty, 1852

Cyclogramma, Perty, 1852, p 146, Stein, 1859 *d*, p 61
Acidophorus, Stein, 1859 *a*, p 59
Nassula (part), Claparède & Lachmann, 1858–61, p 324, Kent, 1880–2, p 494, Butschli, 1887–9, p 1694, Roux, 1901, p 42
Cyclogramma, Kahl, 1930–5, p 224

Comprising a few small species, generally referred to *Nassula*, and agreeing with that genus in form, pigmentation, trichocysts, position, and function of the centrally-situated vacuole The structure of the cytopharynx, however, is characteristic The strong rod-apparatus opens into a pear-shaped depression on the ventral and left side Along the anterior margin of the depression is a short row of small membranellæ, which are recognizable with difficulty The trichocysts are more strongly developed than in *Nassula*

64 **Cyclogramma rubens** Perty (Fig 52)

Cyclogramma rubens, Perty, 1852, p 146, pl iv, fig 10, *a–g*, Stein, 1859 *d*, pp 61–2
Acidophorus rubens, Stein, 1859 *a*, p 59
Nassula rubens, Claparède & Lachmann, 1858–61, p 330, pl xvii, fig 8, Kent, 1880–2, p 495, Schewiakoff, 1896, p 233, Roux, 1901, p 43, pl ii, fig 13
†*Nassula rubens*, Gulati, 1925, p 747, pl i, fig 9
Nassula rubens, Schoenichen, 1927, p 195, fig 720
Cyclogramma rubens Kahl, 1930–5, p 224, fig 34, *24*

Body elongate, cylindrical, three times as long as broad, equally rounded at both extremities, brick-red or rose-coloured Preoral depression little developed, forming a membranoid structure in front of the cytopharynx Cytopharynx slightly dilated anteriorly, with an armature of separate rod-like teeth Trichocysts thick and abundant Contractile vacuole single, spherical, subcentral Macronucleus large, spherical, with a number of chromatin masses Micronucleus small and rounded Feeding on blue algæ

Dimensions —Length up to 90μ

Remarks —The form encountered by Gulati differed from the above description in the ratio of the length to the width of the body His specimens measured 90μ by 50μ, whereas the length recorded by other authors for this species is $50–75\mu$ Gulati shows the micronucleus as lying near the pharyngeal tube, while Kahl shows it near the macronucleus The slight preoral depression, described by Kahl, was not found by Gulati

Habitat —Pond water PUNJAB, Lahore

Genus CHILODONTOPSIS Blochmann, 1895

Chilodontopsis, Blochmann, 1895, p 94, Roux, 1901, p 45, Schœnichen, 1927, pp 194, 196, Kahl, 1930–5, p 225

Strongly flattened, or ventrally flattened and dorsally slightly bulging, elongate, with colourless plasma Ciliated on both surfaces Rod-apparatus without anteriorly prolonged tube, cytostome with a weakly developed ring-shaped membrane Mostly with postoral row of cilia extending from the left side of the cytopharynx or right across the ventral surface (not forming composite structures as in *Nassula*)

Remarks—The genus is intermediate between *Nassula*, which it resembles in ciliation and the presence of a postoral row of cilia, and *Chilodonella*, which possesses a similar rod-apparatus and form and is also colourless

65 Chilodontopsis bengalensis (Ghosh) (Fig 53)

†*Chlamydodontopsis bengalensis*, Ghosh, 1921 *a*, p 8, fig 4
Chilodonella bengalensis, Kahl, 1930–5, p 225

Body elongated oval, anterior end slightly narrower and terminating in a point curved towards the left side, posterior

Fig 53

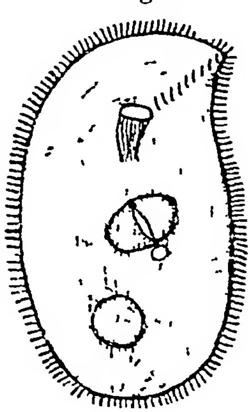


Fig 54

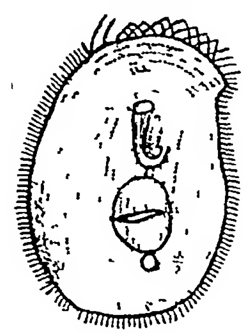


Fig 53 —*Chilodontopsis bengalensis* (Ghosh) (After Ghosh)
Fig 54 —*Orthodonella banerjeei* (Ghosh) (After Ghosh)

end rounded. Body flattened on the ventral and convex on the dorsal surface Cytostome on the ventral surface at one fourth of the length of the body from the anterior end Cytopharynx short and conical, with a rod-apparatus Ciliary striations of the right side curve round to become continuous with those of the left side in front of the cytostome An

adoral row of stout cilia extending from the anterior beak to the cytostome Contractile vacuole single, spherical, near the posterior end Macronucleus oval, central or more posteriorly situated, with a single micronucleus close to it

Dimensions —Not recorded

Remarks —Ghosh has wrongly referred this species to *Chlamydodontopsis* instead of *Chilodontopsis* Blochm Kahl is of the opinion that the form is probably referable to *Chilodonella* According to Ghosh, the species differs from *Chilodontopsis depressa* Perty in shape, shape of the cytopharynx, character of the macronucleus and the shape of the contractile vacuole The macronucleus is described and figured with a transverse septum in the middle What is described as a transverse septum is probably only a cleft, as described for *Chilodontopsis (Nassula) oblonga* which species it closely resembles

Habitat —Vegetable infusion BENGAL, Calcutta

Genus **ORTHODONELLA** (nom nov) (=ORTHODON Gruber, 1884)

Orthodon, Gruber, 1884, p 524, Bütschli, 1887–9, p 1695, Calkins 1926, p 404, Lepsi, 1926 *a*, p 36, Kahl, 1930–5, p 228

Lanceolate or elongate-oval, dorso-ventrally flattened, with a more or less prominent beak-like projection at the anterior end Opening of the rod-apparatus directed to the right Contractile vacuole single, postero-terminal or in the middle of the body Macronucleus oval, central, micronucleus lying close to it

Remarks —As the name *Orthodon* is preoccupied for a genus of Pisces (C F Girard, 1856) I have altered it to *Orthodonella*

66 **Orthodonella banerjeei** (Ghosh) (Fig 54)

†*Orthodon banerjeei*, Ghosh, 1921 *a*, pp 8–9, fig 5
Orthodon banerjeei, Kahl, 1930–5, p 229

Body oval, narrowed anteriorly, broad and rounded posteriorly Anterior end curved to a blunt beak towards left side Body flattened on the ventral and convex on the dorsal surface Cytostome at one-fourth of the body-length from the anterior end Cytopharynx elongated, conical, with the posterior end bent forward A rod-apparatus present A few cilia at the extreme anterior margin of the body longer and stouter than those over the rest of the body Contractile vacuole absent (?) Macronucleus broadly oval, with a transverse partition in the middle, and situate in the posterior half

of the body Micronucleus near the posterior end of the body

Dimensions —Not recorded

Remarks —Kahl is of the opinion that this species also is a *Chilodonella* As regards the presence or absence of cilia on the convex dorsal surface, the size of the organism, and the presence or absence of the contractile vacuole, the description given by Ghosh is incomplete The cytopharynx is directed to the right in *Orthodonella*, but this is not so in the figure given by Ghosh

Habitat —Tank water BENGAL, Calcutta

2 Family CHLAMYDODONTIDÆ Claus, 1874.

Body not provided with cilia on the dorsal surface, at the most only a few bristles may be present Cilia confined to the ventral surface Cytostome situated in the anterior half of the ventral surface Adoral cilia, when present, always as a feebly developed preoral membrane-like structure, never as a postoral row Cytopharynx with a rod-apparatus Posterior end of the ventral surface not provided with styles

Key to Indian Genera

1 Ciliated ventral surface narrowed to a strip, wider anteriorly and pointed posteriorly the unciliated dorsal surface extending inwards on both sides behind the mouth [p 131 PHASCOLODON Stein,

2 Ventral surface ciliated, dorsal surface convex, anterior third or fourth and generally the lateral margins free from this convexity, dorsally with a transverse row of bristles on the anterior flattened part [p 132 CHILODONELLA Strand,

Genus PHASCOLODON Stein, 1859

Phascolodon, Stein, 1859 *a*, p 2, 1859 *d*, p 109, Kent, 1880–2, pp 745–6, Butschli, 1887–9, pp 1697–8, Lepsi, 1926 *a*, p 36, Schoenichen, 1927, pp 193, 198, Kahl, 1930–5, p 232

Small to medium sized Ventral surface longitudinally striated and ciliated, narrowed behind the mouth by extension on both sides of the dorsal unciliated surface, hinder end pointed Cytostome in the anterior part of the ventral surface Cytopharynx funnel-shaped, enclosing a bundle of rods Contractile vacuoles two Locomotion, swimming and rotating on the long axis

67 **Phascolodon** sp (Fig 55)

†*Phascolodon* sp, Chaudhuri, 1929, p 54, pl ii, figs 14, 15, 16

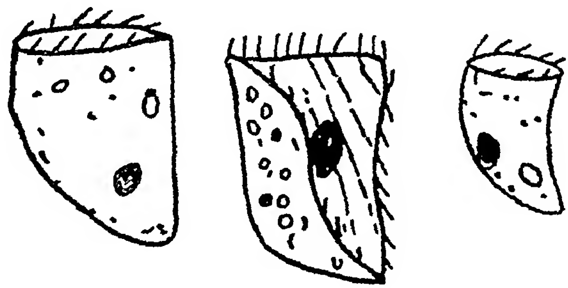


Fig 55—*Phascolodon* sp (After Chaudhuri)

Habitat—In soil CEYLON, Colombo

Genus **CHILODONELLA** Strand, 1926
(=CHILODON Ehrenberg, 1833)

Chilodon, Ehrenberg, 1833, p 287, 1838, p 336, Dujardin, 1841, p 490, Stein, 1859 *d*, p 110, Claparède & Lachmann, 1858–61, p 332, Kent, 1880–2, p 746, Butschli, 1887–9, pp 1695–6, Roux, 1901, p 46, Lepsi, 1926*a*, p 36, Calkins, 1926, p 404
Chilodonella, Strand, 1926, p 31
Chilodon, Schoenichen, 1927, pp 194, 196
Chilodonella, Kahl, 1930–5, pp 234–5

Animalcules free-swimming, small to medium-sized or large, persistent in shape, but more or less flexible, subovate, strongly flattened dorso-ventrally Anterior end produced on the left side into a beak-like projection The dorsal region convex, the ventral surface flat or slightly concave and with fine longitudinal striations Posterior end broad, rounded, only rarely pointed From the cytostome a curved striation bearing somewhat thicker cilia or bristles extends to the beak Cytostome median, in the anterior half of the body, followed by a straight or spirally curved cytopharynx, which is provided with fine well-developed rod-apparatus Contractile vacuoles variable, either single, terminal, or median, or 2, 3, up to numerous, increasing in number with the size of the individual Anal aperture postero-terminal Macronucleus central, oval, showing characteristic structure, micronucleus single, lying close to macronucleus Inhabiting salt and fresh water Penard (1922) has recorded two species as ecto-commensals on *Asellus* or *Gammarus*, freshwater Crustacea

Remarks—The name of the genus has been altered by Strand, as the name *Chilodon* is preoccupied, Ehrenberg having already (1831) given it to a genus of Mollusca

Key to Indian Species

1 (2)	Contractile vacuole single, cytopharynx short and straight	[p 135. *C rhesus* (Ghosh),
2 (1)	Contractile vacuoles more than one	3
3 (4)	Contractile vacuoles several, scattered Cytopharynx long and straight	[Mull), p 133 *C cucullulus* (O F
4 (3)	Contractile vacuoles three, largest posterior Cytopharynx spirally curved behind	[& Mull), p 135 *C spiralidentis* (Bhatia

68 **Chilodonella cucullulus** (O F Muller) (Fig 56)

Kolpoda cucullus, Muller, 1773, p 58, 1786 p 105, pl xv, figs 7–11 p 185, pl xxvi, figs 13–16

Loxodes cucullio O F Muller, 1786, p 106, pl xv, figs 12–15

Loxodes cucullulus, Ehrenberg, 1830, pp 42, 53, 56, 63, 78, pl iv, fig 3, 1831, pp 109, 150

Chilodon cucullulus, Ehrenberg, 1833, pp 169, 174 176, 287, 322, pl ii, fig 1 *a–g*, 1837, pp 164, 166, 1838 pp 336–7, pl xxxv, fig vi

Loxodes cucullulus, Dujardin, 1841, p 451, pl xiii, fig 9

Loxodes cucullio, Dujardin, 1841, p 452

Chilodon cucullulus, Dujardin, 1841, p 491, pl vi, fig 6, Stein, 1854, pp 126–38, 192, 242, 249, pl iii, figs 51–69, 1859 *d*, pp 110–14, pl i, figs 6–23, 1867, pp 20, 41, 44, 49, 59–61, 69, 70, 118

†*Chilodon cucullulus*, Carter 1856*b*, pp 128, 132 248 pl vii, figs 82–3

Chilodon cucullulus Claparède & Lachmann, 1858–61, pp 334–7, Engelmann 1862, pp 350, 368, 387 pl xxviii, fig 4, Kent, 1880–2, pp 746–7, pl xlii, figs 16–22, Bütschli, 1887–9, pp 1695–6, pl lx, fig 8, pl lxi, fig 1, Schewiakoff, 1893, p 40, 1896, p 245, pl iii, fig 73, pl vii, fig 199, Roux, 1901, pp 46–7, pl ii, fig 16

†*Chilodon steini*, Bhatia, 1922 p 30

Chilodon cucullatus, Hollis, 1922, pp 3–7, figs 1–5

Chilodon cucullulus Penard, 1922, pp 90–2, figs. 94, 95

†*Chilodon cucullus*, Gulati, 1925, p 748, pl i fig 11

Chilodon cucullulus Lepsi 1926*a*, p 46, fig 128 Wenyon, 1926 p 1176, fig 496, Schoenichen 1927, p 197, pl xii fig 20, Reichenow, 1929, pp 276, 277, 358 1173, fig 307

†*Chilodon cucullulus*, Bhatia & Mullick 1930, p 394

Chilodonella cucullulus, Kahl, 1930–5 p 235 fig 38, *1–3*

Body asymmetrical, dorso-ventrally flattened, elongate elliptical, deformable Anterior extremity produced into a lamellar beak-like projection, curving towards the left Posterior end of the body rounded Ventral surface flattened and bearing longitudinal ciliary lines, those on the right half curved and running on to the beak, those on the left half running straight Dorsal surface convex Cytostome ventral, situated in the anterior third of the body Cytopharynx straight, wider anteriorly and narrowing posteriorly, containing a number of longitudinal rods From the anterior end of the cytopharynx a line of bristles extends to the beak.

Contractile vacuoles numerous Macronucleus oval, with a small micronucleus close to it

Dimensions—Length 130–150 μ, sometimes up to 300 μ

Remarks—Specimens found at Lahore were much smaller than the size usually given for the species, an average specimen measuring only 90 μ by 42 μ The body was strongly asymmetrical, flattened and flexible, and the animal moved with a gliding and undulating movement The longitudinal striations were fine but well marked, and the ciliation was fine and close The oblique line of bristles, which generally extends from the beak to the cytopharynx, was not present in the specimens that came under my observation Numerous small vesiculæ were distributed in all parts of the body, including the beak The macronucleus was large, oval and

Fig 56

Fig 57

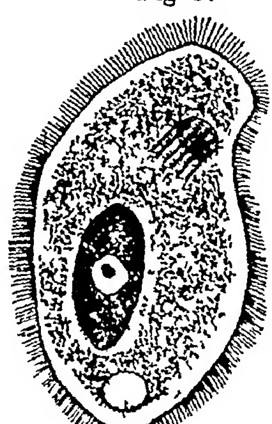


Fig 58

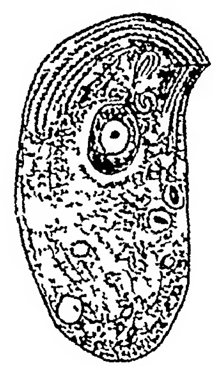


Fig 56—*Chilodonella cucullulus* (O F Mull) *A*, anus, *B*, cytostome, *C V*, contractile vacuole, *Ma*, Macronucleus, *Mi*, micro nucleus, *ph*, cytopharynx (After Roux)
Fig 57—*Chilodonella rhesus* (Ghosh) (After Ghosh)
Fig 58—*Chilodonella spiralidentis* (Bh & Mull) (After Bhatia and Mullick)

finely granular, containing a large central vesicular body The micronucleus could not be made out The body did not contain any diatoms, but round, disc-shaped or oval green algæ In 1922 I referred the form to *C steini*, but that species is now generally merged into *C cucullulus*

Specimens found by Bhatia and Mullick at Srinagar (Kashmir) also measured about 90 μ in length Contractile vacuoles were three in number, two being in the middle, and the third, which was largest, postero-terminal The large oval macronucleus shows a characteristic structure in permanent preparations There is a narrow compact layer of

nucleoplasm extending along the nuclear membrane There is a large spherical nucleolus, surrounded by chromatin granules, which are specially aggregated on two sides of the nucleolus like two caps

Habitat —Pond water KASHMIR, Srinagar, PUNJAB, Lahore, BOMBAY, Bombay

69 **Chilodonella rhesus** (Ghosh) (Fig 57)

†*Chilodon* sp, Knowles, 1928, p 522
†*Chilodon rhesus*, Ghosh, 1929 *b*, pp 15–16, fig 1

Body flattened and elongately ovate, length less than twice the breadth, widest behind the middle Anterior end somewhat tapering, rounded, and slightly bent to the left Dorsal surface convex, ventral surface flattened and ciliated, no dorsal row of cilia Cilia longest in the anterior portion Cytostome circular and situated towards the left side at one-fourth or one-fifth of the body-length from the anterior end Cytopharynx short, truncate, and directed towards the left, with a distinct rod-apparatus Ectoplasm thick, endoplasm coarsely granular Contractile vacuole spherical and postero-terminal Macronucleus large, oval, central or somewhat behind the middle The macronucleus consists of a large clear area, with a small mass of chromatin in the centre, the clear area being surrounded by dense chromatin granules which fill up the rest of the macronucleus Micronucleus not detected Intestinal parasite

Dimensions —Length 50–65μ, width 26–42μ

Remarks —The species differs from others in the absence of an adoral row of cilia, in its short pharynx, and a very short and straight rod-apparatus

Habitat —In the intestine of the common Bengal monkey, *Macacus rhesus* BENGAL, Calcutta

70 **Chilodonella spiralidentis** (Bhatia & Mullick) (Fig 58)

†*Chilodon spiralidentis*, Bhatia & Mullick, 1930, pp 394–5, fig 2

Body flattened, oval, nearly twice as long as broad Dorsal surface convex, ventral surface flat and uniformly ciliated Cilia arranged along parallel lines, which run straight in the left half and curve round to the anterior end in the right half of the body Anterior extremity of the body produced into a flattened beak slightly curving to the left Cytostome situated some distance behind the anterior end, followed by a cytopharynx which is wider in front and the narrow portion of which is spirally curved Cytoplasm vacuolated Contractile

vacuoles three, the largest near the posterior end Macronucleus somewhat oval and surrounded by a clear space The nuclear membrane has a wavy zone of nucleoplasm adhering to it all round There is a large, centrally placed nucleolus with a dark central karyosome Chromatin granules are compactly arranged in two masses on the anterior and posterior sides of the nucleolus and less densely laterally

Dimensions —Length 97 μ

Remarks —The movement is usually gliding, but sometimes the animal swims forward and rotates on its axis The length of the animal is 97 μ and the maximum width 53 μ

The species, as defined above, shows some resemblance to *C cucullulus* (Muller) and *C uncinatus* (Ehrbg) It resembles *C cucullulus* in the arrangement of the ciliary lines and the structure of the nucleus, but differs from it in the form of the cytopharynx, which is spirally curved It resembles *C uncinatus* in having the cytopharynx spirally curved, but differs from that species in the structure of the nucleus, the number and disposition of the contractile vacuoles, and its larger size

Habitat —Pond water KASHMIR, Srinagar

71 **Chilodonella** sp

†*Chilodon* sp , Chaudhuri, 1929, p 54, pl iii, fig 7

Remarks —Chaudhuri gives no description, and the organism cannot be identified from the rather crude diagram given by him

Habitat —Soils BENGAL, Sibpore , CENTRAL INDIA, Indore

72 **Chilodonella** sp

†*Chilodon* sp , Simmons, 1889, p 4

Habitat —Pond water BENGAL, Calcutta

2. Suborder *TRICHOSTOMATA* Butschli, emend Kahl

HOLOTRICHA with body usually covered entirely with cilia A well-developed peristomial depression or groove, the surface of which is ciliated, leads to the cytostome, and causes a spiral twisting of the body Cytostome is kept permanently open and the food is brought in by a whirlpool Cytopharynx tubular, not containing a rod-apparatus Both the cytostome and the cytopharynx are provided with specially thickened cilia, which are not united to form membranes but help to direct the current, containing food particles, down the cytopharynx

Remarks—Butschli used the term TRICHOSTOMATA to include all groups of CILIATA other than the GYMNOSTOMATA He divided the order TRICHOSTOMATA into the suborders ASPIROTRICHA (including all the HOLOTRICHA except GYMNOSTOMA) and SPIROTRICHA (including HETEROTRICHA, OLIGOTRICHA, HYPOTRICHA and PERITRICHA) Calkins (1926) applied the term TRICHOSTOMINA to those HOLOTRICHA in which there is always a ciliated peristomial groove and special cilia, which may be free or united to form membranes, in the cytostome or the cytopharynx This group had been previously designated as HYMENOSTOMATA by Delage and Hérouard (1896), Schewiakoff (1896), Hickson (1901) and Minchin (1912) Kahl (1926, 1930–5) still further restricted the term TRICHOSTOMATA to a suborder of HOLOTRICHA in which there is a ciliated peristomial groove and the oral and pharyngeal cilia are not united to form membranes, and he also restricted the term HYMENOSTOMATA to those in which the oral and pharyngeal cilia are united to form membranes Reichenow (1929) has followed Kahl in this usage of these terms

Identification Table of Families

A *Fresh-water*

1 (2)	Small, ovoid Infusoria, with a ciliated peristomial groove, which surrounds half of the anterior end, and a projection provided with bristles extending beyond it They secrete a delicate gelatinous test, swim backwards	**Marynidæ** * Poche
2 (1)	Other forms, building no test	3
3 (4)	Small, generally strongly flattened laterally, with delicate, coat-of-mail-like pellicle Cilia sparse, particularly on the right f[illegible]	

	where they form a semicircular or sickle shaped uninterrupted dorsal keel, and 2–9 interrupted rows on the plane surface Cytostome on the compressed ventral surface, membranoid structures generally recognizable with difficulty Two contractile vacuoles	Trichopelmidæ Kahl, [p 153
4 (3)	Other forms, differently ciliated	5
5 (6)	Small to very small Infusoria with long tail like process, the body cilia occupy only the anterior half in 3–4 transverse spirals	Trimyemidæ* Kahl [(=Sciadostomidæ* Kahl)
6 (5)	Without a tail like process and differently ciliated	7
7 (10)	A zone of special cilia extends spirally from the mouth to the hinder end	8
8 (9)	Spiral zone extends from the anterior right to the posterior left (optical)	Spirozonidæ* Kahl
9 (8)	Spiral zone extends from the anterior left to the posterior right (optical)	Trichospiridæ* Kahl
10 (7)	Without special spiral row	11
11 (12)	On the ventral side a ciliated transverse groove runs to the cytostome	Plagiopylidæ Schew, [p 139
12 (11)	Without ventral transverse groove	13
13 (14)	Cytostome in the first fourth in a shallow oval longitudinal groove, the walls of which are provided with uniformly thick cilia	Clathrostomidæ* Kahl
14 (13)	Cytostome deepened in a funnel-like manner	15
15 (16)	From the anterior end a broad peristomial groove runs backwards and to the right up to the middle of the body, at the bottom of which lies the characteristic oral funnel (vestibule) Oral funnel with a strong ciliary field	Parameciidæ Kent, [p 145
16 (15)	Without a depression extending backwards from the anterior end	17
17	Oral funnel with tunnel shaped passage, with a ciliary field at the lower and another at the upper side of the funnel Free living, mostly moss inhabiting forms	Colpodidæ Poche [p 141

Incertæ sedis

1	Form oval or lanceolate, strongly flattened, posteriorly drawn out Cytostome a very short ciliated groove near the anterior end	Entorhipidiidæ* [Madsen
2	Form obovate, with a posterior bunch of gelatinous threads fixing the body to the substratum, and with a stiff bristle arising from the posterior end of the body Cytostome in the centre of the ventral surface	Lagenellidæ* Grand [(=Centrostomatidæ*)
3	Form elongate, very contractile Cytostome a long, simple, and narrow groove, lying along the ventral margin near the anterior end	Geleiidæ* Kahl

B *Parasitic*

1 (6) Entire body covered with cilia 2
2 (3) Cytostome ventral, connected by a groove with the anterior end, or numerous small cytostomes along the whole length of the groove, parasites of mammals [Chatt & Per). [(=Nicollellidæ* Pycnothrichidæ* Poche
3 (2) Cytostome ventral, not connected by a groove with the anterior end 4
4 (5) Cytostome ventral, near the posterior end, concretion vacuole absent, parasites in the stomach of ruminants [p 156 Isotrichidæ Bütsch,
5 (4) Cystostomial groove on the ventral surface between it and the anterior end of the body is a frontal field covered with longer cilia, concretion vacuole present, parasites in the cæcum of horse [da Cunha Paraisotrichidæ*
6 (1) Cilia over certain regions of the body only 7
7 (8) *Peristome occupies entire anterior end*, cilia limited to the peristomial field and adjacent part of the body, parasites in the cæcum of guinea-pigs [da Cunha Cyathodiniidæ*
8 (7) Cytostome not terminal, tufts of cilia above and below cytostome and in posterior anal region, parasites in the stomach of ruminants [Hsiung, p 160 Blepharocoridæ

* In addition to the families enumerated above, Protohallidæ da Cunha & Muniz (1927) and Sulcigeridæ Gajewskaja (1933) may be mentioned, each based on a single species

1. Family PLAGIOPYLIDÆ Schewiakoff, 1896.

Dorso-ventrally flattened, oval to ovoidal forms Without a tail-like process of the body and without a special spiral zone of cilia On the ventral side of the body a ciliated groove runs transversely across to the cytostome. Cytostome followed by a short ciliated cytopharynx.

Genus PLAGIOPYLA Stein, 1860

Plagiopyla, Stein, 1860 *a*, pp 57, 58–9, Kent, 1880–2, p 538, Bütschli, 1887–9, p 1704, Roux, 1901, p 76, Penard, 1922, p 186, Lepsi, 1926 *a*, p 51, Calkins, 1926, p 406, Schoenichen, 1927, p 219, Kahl, 1930–5, p 264

Body elongated oval, flattened On the anterior fourth of the ventral surface a peristomial groove runs transversely across from the right margin of the body, and is provided along both margins with thicker cilia, which are, however,

not united to form membranelles At its end is the cytostome, followed by a short ciliated cytopharynx Macronucleus rounded, with a small rounded micronucleus close to it

73 **Plagiopyla (?) carteri** Kent (Fig 59)

†*Plagiopyla (?) carteri*, Kent, *1880–2*, p *538*, pl xxvi, fig *69*

Body elliptical, cylindrical, equally rounded at the two extremities, about twice as long as broad Cytostome nearly mid-way between the centre and the anterior extremity of the body, enclosing a minute, lunate, undulating membrane, followed by a conically-pointed tubular cytopharynx, anal aperture lateral, on the same surface as the mouth, but nearer the posterior extremity Cuticular cilia short, disposed in even longitudinal rows Contractile vacuole lateral, subcentral Macronucleus undetermined

Dimensions—Length 200 μ

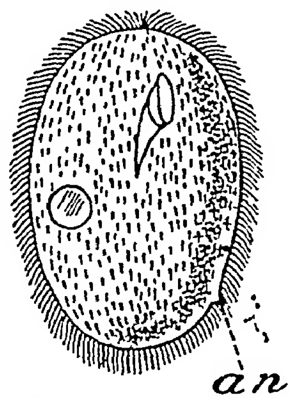


Fig 59—*Plagiopyla* (?) *carteri* Kent *an*, anal aperture (After Kent)

Remarks—The form figured and briefly described by H J Carter in his manuscript notes under the title of *Paramœcium* ? was described as a new species by Kent, and was tentatively referred to *Plagiopyla* It does not, however, seem to belong to this genus, as there is no peristomial groove running transversely across from the right margin of the body Further, the cytopharynx as figured does not show any cilia, but a lunate membrane Kent himself was doubtful and thought that the form would perhaps be more rightly referred to the genus *Ophryoglena* But in my opinion the form cannot even be referred to *Ophryoglena*, as the characteristic deeply-sunk oral groove is wanting

Habitat—Fresh water. BOMBAY, Bombay

2. Family COLPODIDÆ Poche, 1913, emend. Kahl, 1926.

The body cilia run in rows arranged in a concentric manner round the convex oral margin on the ventral surface and diagonally on the dorsal surface Body is without a depression extending backwards from the anterior end A funnel-shaped groove, in the anterior half of the body, runs across one of the surfaces of the body Both upper and lower sides of the funnel bear ciliary fields These cilia are (according to Kahl) not united into membranes Cytostome followed by a short cytopharynx leading to a food vacuole Alveolar layer of the ectoplasm always contains short trichocysts or trichocyst-like, round, shining bodies Contractile vacuole single, posterior Macronucleus spherical or slightly oval and contains a nucleolus

Genus **COLPODA** O F Muller, 1773

Kolpoda, Muller, 1773, pp 56–7
Colpoda, Gmelin, 1791, p 3894, Ehrenberg, 1838, p 346
Kolpoda (part), Dujardin, 1841, p 478
Colpoda, Claparède & Lachmann, 1858–60, p 270, Kent, 1880–2, p 512, Rhumbler, 1888, pp 549–601, Bütschli, 1887–9, p 1707, Schewiakoff, 1896, p 306, Roux, 1901, p 57, Enriques, 1908 *a*, p 272, 1908 *b*, pp i–xv, Calkins, 1926, p 406, Lepsi, 1926 *a*, p 53, Schoenichen, 1927, p 207, Sandon, 1927, p 183, Kahl, 1930–5, p 273

Body kidney-shaped, laterally flattened Dorsal surface strongly convex, ventral plain or convex, provided with a deep depression in the anterior part or in the middle Anterior end rounded, twisted from left to right and curved on the ventral face Posterior end uniformly enlarged and rounded Cilia long, fine, and closely arranged in longitudinal rows Cytostome in the ventral depression, oval, usually described as provided with an undulating membrane Cytopharynx absent or rudimentary, described by Roux as short, curved and provided with a narrow undulating membrane According to Kahl undulating membranes, as also the lip-like projection described by Enriques, are absent, these investigators having wrongly interpreted the projecting marginal cilia as such Anus posterior Contractile vacuole single, posterior Macronucleus variable in form The organism divides after encystment into two or four daughter organisms Locomotion rapid, with changes of aspect Feeding on bacteria.

Key to Indian Species

8 to 10 frontal dentations, macronucleus with lobate karyosome — *C cucullus* O F Müll, [p 142
6 to 7 frontal dentations, macronucleus with lobate karyosome . *C maupasi* Enriques, [p 143
6 to 7 frontal dentations, macronucleus with non-lobate karyosome *C steinii* Maupas, [p 144

74 Colpoda cucullus O F Muller (Fig 60)

Kolpoda cucullus, O F Müller, 1773, p 58, 1786, p 102, pl xiv, figs 7–14
Colpoda cucullus, Ehrenberg, 1838, pp 347–8, pl xxxix, fig 5
Kolpoda cucullus, Dujardin, 1841, pp 479–81, pl iv, fig 29, pl xiv, fig 5 (*1*)
Colpoda cucullus, Stein, 1854 *d*, pp 15–25, 34–5, 131, 204, pl iii, figs 1–31, 1867, p 48, Claparède & Lachmann, 1858–60, p 270, Kent, 1880–2, pp 512–3, pl xxvii, figs 19–23, Maupas, 1883, pp 430–6, pl xix, figs 1–6, Rhumbler, 1888, pp 549–601, pl xxxvi, figs 1–57, Bütschli, 1887–9, p 1707, pl lxii, fig 7, Schewiakoff, 1893, p 48, 1896, p 307, pl iv, fig 111
†*Colpoda cucullus*, Daday, 1898, p 8
Colpoda cucullus, Roux, 1901, p 58, pl iii, fig 11, Enriques, 1908 *b*, pp vi–vii, figs 1, 2
†*Colpoda cucullus*, Bhatia, 1916, p 182, Ghosh, 1921 *a*, p 9, fig 6; Gulati, 1925, p 749, pl ii, fig 16
Colpoda cucullus, Lepsi, 1926 *a*, p 62, figs 216–19, Wenyon, 1926, p 1179, fig 498, Schoenichen, 1927, p 207, pl xii, fig. 32
†*Colpoda cucullus*, Sandon, 1927, p 183, pl vi, fig 1, Madhava Rao, 1928, p 114, pl iii, fig 4, Chaudhuri, 1929, p 60, pl ii, figs 10, 11, 12
Colpoda cucullus, Reichenow, 1929, pp 1175–6, 1187, fig 1159, Kahl, 1930–5, p 277, fig 47, *1–3*

Body strongly kidney-shaped, with a well-marked depression, the ventral side with strong furrows which give the anterior end a curved appearance Frontal dentations 8 to 10 Colour yellowish or brown owing to large number of food-vacuoles being filled with algæ Cytopharynx absent, or short and curved Cilia of the oral region projecting in a tuft-like manner Contractile vacuole large, single, posterior Macronucleus oval, central, with a lobed karyosome Reproduction occurs in cysts, and just before excystation cysts contain two or four individuals actively rotating

Dimensions.—Length very various, from 40–120 μ, average 80 μ Cysts on an average about 35 μ in diameter

Remarks—*C cucullus* is one of the commonest soil Ciliates It is larger than the two other species, and the part behind the mouth is very swollen and almost globular Reproduction often occurs in the cysts, which are about 35 μ in diameter

Habitat—In soil KASHMIR, PUNJAB, SIND, BOMBAY, MYSORE, MADRAS, HYDERABAD, CENTRAL PROVINCES, UNITED

PROVINCES, ORISSA, BENGAL, ASSAM, and BURMA In vegetable infusions. PUNJAB, Lahore, and BENGAL, Calcutta In fresh water CEYLON

Fig 60

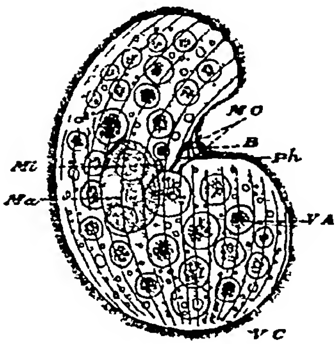


Fig 61

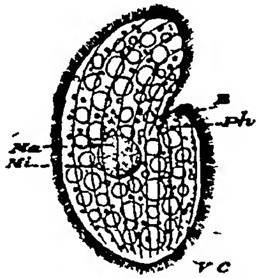


Fig 62

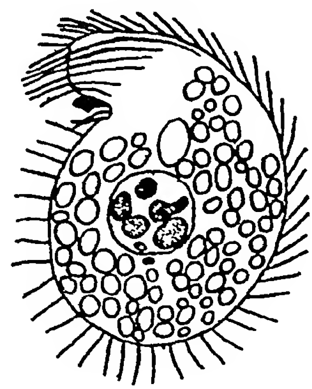


Fig 60—*Colpoda cucullus* O F Müll *B*, cytostome, *Ma*, macronucleus, *Mi*, micronucleus, *M O*, undulating membrane *ph*, cytopharynx, *V.A*, food-vacuole, *V C*, contractile vacuole (After Roux)
Fig 61—*Colpoda steinii* Maupas Lettering as in fig 60 (After Roux)
Fig 62—*Colpoda maupasi* Enriques (After Sandon)

75 Colpoda maupasi Enriques (Fig. 62)

Colpoda maupasi, Enriques, 1908 *b*, pp vii–xi, figs 3–5, 9, Wenyon, 1926, p 1180
†*Colpoda maupasi*, Sandon, 1927, p 183, pl i, fig 24, pl vi, fig 2
Colpoda maupasi, Kahl, 1930–5, p 279, fig 47, *12*

Body oval and cylindrical, more elongated than *C steinii*, with the anterior end more rounded Frontal dentations 6 to 7 Left margin with small, but distinct, semicircular excavation Macronucleus spherical, with a lobate karyosome, and with a micronucleus lying close to it

Dimensions—Length 35–70 μ Cysts smaller, about 15–20 μ in diameter

Remarks—According to Enriques this species cannot be induced to conjugate readily like *C. steinii* The cysts, which are smaller than in the other two species are enclosed in a thick, structureless, mucilaginous outer layer, which is not so corrugated as the outer wall in the other species In older cysts this outer layer condenses into a relatively thin and highly refringent wall

Habitat—In soils BENGAL, Pusa, and MADRAS, Madras and Coimbatore

76 **Colpoda steinii** Maupas (Fig 61)

Colpoda steinii, Maupas, 1883, pp 436–43, pl xix, figs 7–14, Bütschli, 1887–9, p 1707, pl lxii, fig 8, Schewiakoff, 1896, p 308, pl iv, fig 112, Roux, 1901, p 58, pl iii, fig 12
Colpoda steini, Enriques, 1908 *a*, p 272, 1908 *b*, pp xi–xiii, figs 6–8, 10
Colpoda steinii, Lepsi, 1926 *a*, p 62, figs 220–2
Colpoda steini, Wenyon, 1926, pp 1179–80, fig 498, Schoenichen, 1927, p 208, fig 733
†*Colpoda steinii*, Sandon, 1927, p 183, pl vi, fig 3
†*Colpoda steini*, Madhava Rao, 1928, p 114, pl iv, fig 3
†*Colpoda steinii*, Chaudhuri, 1929, p 60, pl ii, figs 1–9, pl iv, figs 9, 12, Bhatia & Mullick, 1930, p 395
Colpoda steini, Kahl, 1930–5, p 279 fig 47, *13*, and p 281, fig 46, *14*

Body oval and cylindrical, relatively more elongated than in the preceding species, anteriorly more narrowed Frontal dentations 6 to 7. Ventral surface nearly flat Posterior end less broad Ventral depression less pronounced than in *C cucullus* Colour deep grey Cytostome situated at the bottom of the depression and followed by a short tubular cytopharynx Large food vacuoles often present Contractile vacuole single, in the posterior region of the body Macronucleus central, spherical or oval, with a non-lobate karyosome, and with a micronucleus close to it

Dimensions —Length 25–60 μ, width 9–15 μ Cysts smaller than in *C cucullus*, being about 25 μ in diameter

Remarks —*C steinii* is also one of the commonest soil ciliates It is smaller than *C cucullus*, and is not inflated behind, so that the ventral surface is quite flat except for the notch which leads to the mouth The anterior end is also more pointed than in *C cucullus* Reproduction takes place in cysts The specimens found at Srinagar possessed a tuft of longer cilia at the posterior end of the body, and measured about 53 μ in length

Habitat —In soil BEHAR, Pusa, ASSAM, Cinnamara, BOMBAY, Poona, KANARA, MADRAS, Coimbatore, BURMA, Hmawbi (*Sandon*), MYSORE (*Madhava Rao*), N W F PROVINCE, Peshawar, PUNJAB Ghora Gali, Lahore, Delhi, UNITED PROVINCES, Dehra Dun, BOMBAY, Bombay, Dharwar, CENTRAL INDIA, Indore, CENTRAL PROVINCES, Nagpur, HYDERABAD, MADRAS, Madras, BURMA, Rangoon, CEYLON, Colombo (*Chaudhuri*) In pond water KASHMIR, Srinagar

77 **Colpoda** sp

Colpoda sp, Knowles, 1927, p 522

Habitat —In cultures of *Paramecium* BENGAL, Calcutta

3. Family PARAMECIIDÆ Kent, 1881, emend. Kahl, 1931.

Body elongate and cigar-shaped or shorter and plumper, finely ciliate throughout, usually with longer cilia at the posterior end From the anterior end of the body a broad peristomial groove runs backwards and to the right, to the middle of the body Cytostome at the bottom of the peristomial groove, followed by a funnel-shaped cytopharynx Oral funnel with a strong ciliary field, a row of very fine cilia being attached to the dorsal wall of the cytopharynx Contractile vacuoles, usually two, with radiating canals Macronucleus oval, with one, two, or numerous micronuclei

Genus **PARAMECIUM** Hill, 1752, emend Stein, 1860

Paramæcium, Hill, 1752, Müller, 1773, p 54

Paramecium, Gmelin, 1791, p 3895, Rafinesque-Schmaltz, 1814, p 89, Ehrenberg, 1838, p 349, Dujardin, 1841, p 481, Claparède & Lachmann, 1858–61, p 263, Fromentel, 1876, p 183

Paramæcium, Kent, 1880–2, p 483, Bütschli, 1887–9, pp 1710–1, pl lxiii, Schewiakoff, 1896, p 334

Paramecium, Roux, 1901, p 67, Woodruff 1921 *a*, pp 171–180, Calkins, 1926, p 407, Wenyon, 1926, pp 1163, 1175

Paramæcium, Lepsi, 1926 *a*, p 50, Schoenichen, 1927, p 211, Sandon, 1927, p 185

Paramecium, Wenrich, 1928 *b*, pp 275–82, pls xxvi–xxvii

Paramæcium, Reichenow, 1929, pp 1175–7

Paramecium, Kahl, 1930–5, p 289

Animalcules free-swimming, medium-sized to large, ovate or elongate, asymmetrical, more or less flexible but persistent in shape, finely ciliate throughout, usually with a group of longer cilia at the posterior end, the cilia of the oral region not differing in size or character from those of the general surface of the body, a complete layer of trichocysts abundantly developed An oblique peristomial groove developed on the ventral surface, at the posterior extremity of which, at or about the middle of the ventral surface of the body and to the right of the median line, the cytostome is situated, cytopharynx moderately long, with a row of very fine cilia attached to its dorsal wall, a membranelle present according to some, absent according to others One or more, commonly two, contractile vacuoles, usually with radiating canals Macronucleus oval, central or subcentral, with one, two, or numerous micronuclei One species coloured green owing to the presence of zoochlorellæ Locomotion quick and uniform, with frequent pauses, and sometimes rotating on its longitudinal axis *Fresh water or marine, very common*

Remarks—Maier (1903), Minchin (1912), Luhe (1913), Bourne (1921) and various other authors described one or more undulating membranes attached to the dorsal wall of the cytopharynx Bozler (1924), v Gelei (1926–7) and Kahl (1930–5) showed that there are no undulating membranes, but only free cilia attached to the wall of the cytopharynx, thus necessitating the transfer of the genus from HYMENOSTOMATA to TRICHOSTOMATA More recently v Gelei (1934) has published a thorough study of the detailed structure of the cytopharynx of *Paramecium*, and comes to the conclusion that the cytopharynx consists of three sections, viz, the vestibule, the pharynx and the œsophagus The first bears free cilia, the second possesses membranes showing a characteristic Hymenostomatous structure, and the third part contains fibres or elements which can be compared with the rods in the gullet of GYMNOSTOMATA. On the strength of these observations, he remarks that *Paramecium* can neither be placed among HYMENOSTOMATA nor among TRICHOSTOMATA, but should be placed in a new suborder lying between the two, for which he proposes the name TRICHOHYMENOSTOMATA

Woodruff (1921) pointed out that in this genus the species fall into two groups according to the shape of the body, namely (*a*) The "*aurelia* group," with cigar-shaped bodies, round in cross-section and tapering to a point at the posterior end, and (*b*) the "*bursaria* group," broadly elliptical in cross-section and rounded at the posterior end In either group two types of micronuclear structure may be found, viz, (*a*) the "*caudatum* type," in which the micronucleus is a relatively large, rather compact mass of chromatin, and (*b*) the "*aurelia* type," in which the micronuclei are small and distinctly vesicular in organization On the basis of these facts Wenrich (1928) has recognized eight well-defined species, and he considers that no description of a species can be considered complete unless it includes a description of the type and number of micronuclei

Key to Indian Species

1 (4) Body cigar shaped, widest near or a little posterior to the middle and tapering towards both ends, but more pointed at the posterior end, round in cross section posterior to the cytostome, length usually more than three times the width 2

2 (3) Length usually between 120 and 180 μ, posterior end narrowed but less sharply pointed (about 90°) than in the other species, two contractile vacuoles, two small vesicular micronuclei [p 147] *P aurelia* Ehrbg,

3 (2). Length commonly between 200 and 300 μ, posterior end more pointed than in

P aurelia, normally two contractile vacuoles, single micronucleus relatively large and compact [p 150 P caudatum Ehrbg,

4 (1) Body somewhat compressed dorso ventrally, rounded posteriorly, usually not more than three times as long as wide 5

5 Body usually containing small green algæ (zoochlorellæ), usually 120–160 μ in length, cyclosis relatively rapid, single micronucleus relatively large and compact [p 148 P bursaria (Ehrbg).

78 **Paramecium aurelia** Ehrenberg (Fig 63, A & B)

Paramæcium aurelia, Ehrenberg, 1833, pp 172, 176, 179, 323, pl III, fig 1, 1838, pp 350–1, pl xxxix, fig 6
Paramecium aurelia, Dujardin, 1841, pp 480–3, pl VIII, figs 5, 6
Paramæcium aurelia, Stein, 1854, pp 239–40, 240–3, 1859 *a*, p 58, 1859 *d*, pp 52, 58, 61–2, 77, 78, 87, 97–101, 1861, p 65, 1867, pp 9, 24, 31, 39, 41–4, 47, 48, 50, 53 58–9, 65, 67, 75–6, 88–92, 95–9, 118–9, 121
†*Paramecium aurelia*, Carter 1856 *b*, pp 115–32, 221–49, pl VI, figs 65–9
Paramæcium aurelia, Claparède & Lachmann, 1858–61, pp 49–50, 54–5, 263–5, vol II, pp 199–200, 256, 259–61, 264, 291, pl XI, figs 8–17, Balbiani, 1860, pp 1192–3, 1861, pl IX, figs 23, 24, Pritchard, 1861, p 634, pl xxv, figs 329–32, Engelmann, 1862, pp 349, 368, 387, 391, 1876, pp 604–9, Fromentel, 1874, p 296, pl XVI, fig 8, Mereschkowsky, 1879, p 254, Maupas, 1883, pp 607–61, pl XX fig 18, pl XXI, figs 14, 15, 1886 *a*, pp 1569–72, 1886 *b*, pp 482–4, 1888 *a*, p 234, pl x, fig 12, 1889, pp 215–28, pls XII, XIII, figs 1–33, Schewiakoff, 1896, pp 339–40, pl v, fig 126
Paramecium aurelia, Roux, 1901, p 67, pl IV, fig 3, Woodruff, 1911 *b*, pp 223–37, Lepsi, 1926 *a*, p 58, fig 229, Calkins, 1926, p 541, fig 226, Wenyon, 1926, pp 55, 64, 114, 131, figs 34 & 37, Schoenichen, 1927, p 211, fig 735, Wenrich, 1928, p 279, pl XXXVI fig 3
Paramæcium aurelia, Reichenow, 1929, p 1177, figs 1160 B & 1143
†*Paramecium aurelia*, Bhatia & Mullick, 1930, p 396
Paramecium aurelia Kahl, 1930–5, p 291, fig 48, *3*, *4*

Body elongated, ellipsoid, rounded at both extremities, posteriorly drawn into a tapering but less pointed end, which is generally not provided with the posterior tuft of cilia Cilia over the body uniform Peristomial groove about two-thirds of the body, running obliquely. Trichocysts well developed Contractile vacuoles two, with radiating canals, situated along the right border Anus ventral, in the posterior part of the body Macronucleus oval, with two small vesicular micronuclei Common in infusions and stagnant water

Dimensions—Length 75–290μ, usually between 120 and 180μ, width 15–50μ

Remarks—Smaller in size and less pointed at the posterior end than P *caudatum* In specimens examined at Srinagar

and Lahore there was no tuft of longer cilia at the posterior end In the stained preparations two vesicular micronuclei are seen, situated one on each side of the macronucleus

Habitat—Fresh water KASHMIR, Srinager, PUNJAB, Lahore, BOMBAY, Bombay

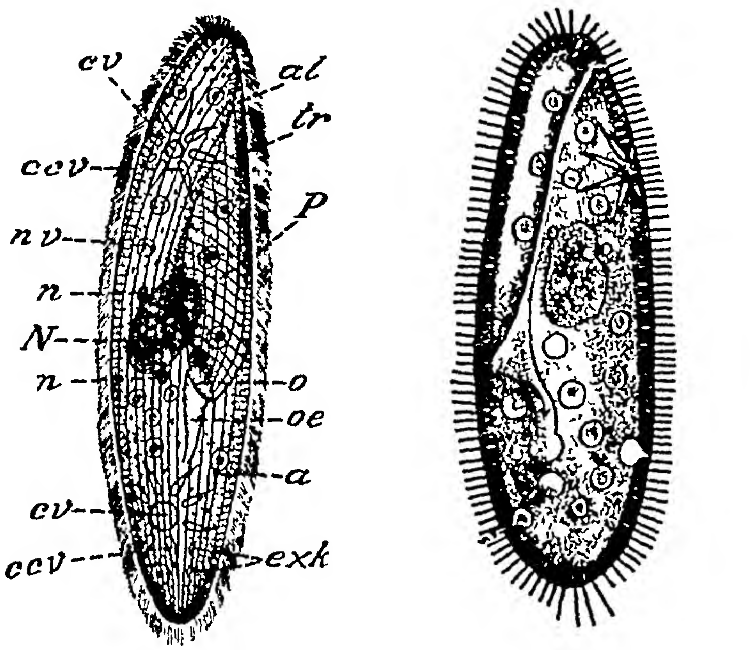


Fig 63—A *Paramecium aurelia* Ehrbg *a*, anus, *al*, alveolar layer, *cv*, contractile vacuole, *ccv*, radiating canals, *exk*, excretory granules, *N*, macronucleus, *n*, micronucleus, *nv*, food-vacuole, *o*, cytostome, *oe*, cytopharynx, *P*, peristomial groove, *tr*, trichocysts (After Schewiakoff) B *Paramecium aurelia* Ehrbg, showing micronuclear structure (After Wenrich)

79. Paramecium bursaria (Ehrenberg) Focke (Fig 64, A & B)

Loxodes bursaria, Ehrenberg, 1833, pp 238–45, pl iv, figs 6–10, 1838, pp 324–5, pl xxxiv, fig 3
Paramecium bursaria, Focke, 1836, pp 786–7, 1843, p 227
Loxodes bursaria, Cohn, 1851, pp 260–78, pl vii, figs 1–6, 1854 *b*, pp 422–8, pl xxii, figs 1–3
Paramecium bursaria, Claparède & Lachmann, 1858–61, pp 265–6, 344, vol ii, pp 193–7, 256, 266, pl x, figs 20–4, Stein, 1859 *d*, pp 16, 43–4, 52, 57, 88, 97, 1867, pp 41–4, 50, 53–5, 58–9, 65, 76, 89, 91–2, 95, 98, 118–19, 121, Engelmann, 1862, pp 348–9, 368, 387, 391, 1876, pp 609–11, Kent, 1880–2, pp 486–7, pl xxvi, figs 31, 32, Bütschli, 1887–9, pp 1710–11, pl lxiii, figs 2 *a–d*, 3 *a*, *b*, *d–g*, 5 *a–c*, Maupas, 1883,

pp 607-61, 1886 *a*, p 1573, 1888 *a*, pp 234-5, pl xii, fig 16, 1889, pp 224-38, pls xiii, xiv, figs 1-21, Schewiakoff, 1893, pp 52-3, 1896, pp 341-2, pl v, fig 128, pl vii, fig 204, Roux, 1901, p 68, pl iv, fig 5, Hamburger, 1904, pp 199-239, pls vii-ix & 2 figs, Lepsi, 1926 *a*, p 58, fig 231, Calkins, 1926, p 385, fig 170, Schoenichen 1927, pp 211-12, pl xii, fig 41, Wenrich, 1928, p 280, pl xxxxvii, fig 5, Reichenow, 1929, p 1177, fig 1160 c

†*Paramecium bursaria*, Bhatia & Mullick, 1930, p 396

Paramecium bursaria, Kahl, 1930-5, p 293, fig 48, *13*

Body oval, flat, little more than twice as long as broad, rounded and wide posteriorly, narrowest and obliquely truncate at the anterior extremity Peristomial groove flat, infundibulate very wide anteriorly, extending obliquely backwards

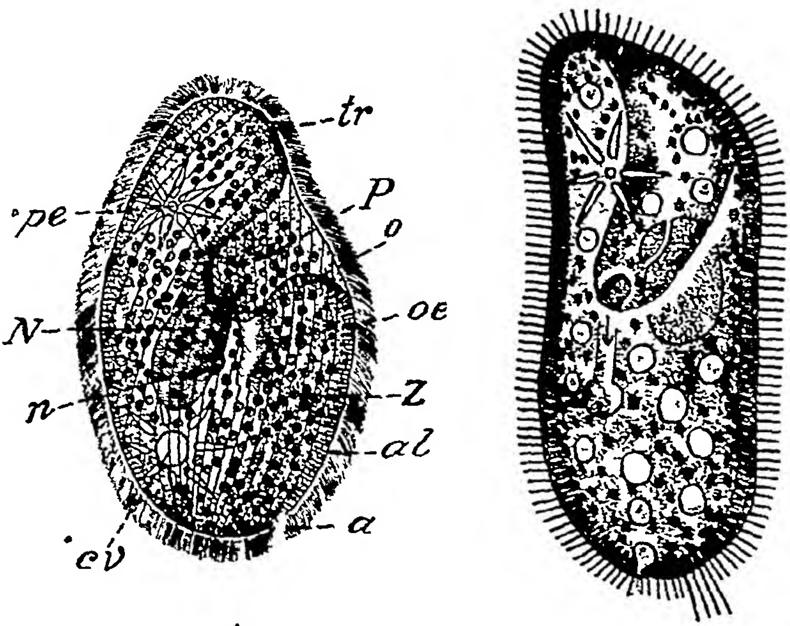


Fig 64—A *Paramecium bursaria* (Ehrbg) *a*, anus, *al*, alveolar layer, *cv*, contractile vacuole, *N*, macronucleus, *n*, micronucleus, *o*, cytostome, *oe*, cytopharynx, *P*, peristomial groove, *pe*, excretory pore, *tr*, trichocysts, *Z*, zoochlorellæ (After Schewiakoff) B *Paramecium bursaria* (Ehrbg), showing micronuclear structure (After Wenrich)

from left to right to beyond the centre of the body Cytostome situated at the posterior extremity of the groove, followed by a distinct cytopharynx Trichocysts abundantly developed, under the trichocyst coat the cortical and endoplasmic layers mostly coloured green owing to the presence of numerous zoochlorellæ Contractile vacuoles two in number,

spherical or stellate Anal aperture postero-terminal Macronucleus oval, with a simple, relatively large and compact micronucleus lying close to it In marsh water, common among plants in standing water

Dimensions —Length 90–306 μ, usually 120–160 μ

Remarks —This species can be readily recognized by its size (usually 120–160 μ in length), rounded posterior end, green colour due to the presence of numerous small green algæ or zoochlorellæ, and rapid cyclosis In combination with these characters staining will show a relatively large single micronucleus of the *caudatum*-type, and thus make identity certain

The specimens found at Lahore were typical in every respect except that they were of a somewhat smaller size than is usual for this species One specimen measured 84 μ by 40 μ and another 95 μ by 42 μ The body was oval and obliquely truncate anteriorly The contractile vacuoles were two in number, spherical and without any radiating canals in some individuals and stellate in others The macronucleus was kidney-shaped and the micronucleus was situated in the notch

The species was also commonly met with at Srinagar (Kashmir) The form was, as usual, dorso-ventrally flattened and the posterior end rounded Cytoplasm full of small green algæ and showed rapid cyclosis Peristomial groove rather small in length as compared with the size of the animal Macronucleus large, central, kidney-shaped Micronucleus single, of massive type, and lying in the depression of the macronucleus Some of the specimens were extraordinarily large, one measuring as much as 306 μ in length

Habitat —In stagnant water . KASHMIR, Srinagar , PUNJAB. Lahore

80 **Paramecium caudatum** Ehrenberg (Fig 65, A & B)

Paramæcium aurelia, O F Muller, 1773, p 54 , 1786, p 86, pl xii, figs 1–14

Paramecium caudatum, Ehrenberg, 1833, pp 268, 323, pl iii, fig 2 , 1838, pp 351–2, pl xxxix, fig 7 , Dujardin, 1841, p 483, pl viii, fig 7 , Stein, 1867, p 44

Paramecium aurelia, Kent, 1880–2, pp 483–6, pl xxvi, figs 28–30

Paramecium caudatum, Maupas, 1886 *a*, p 1572 , 1886 *b*, pp 482–4 , 1888 *a*, pp 230–3, pl x, figs 10, 11 , 1889, pp 181–215, pls lxiii, figs 1–64 , Butschli, 1887–9, pp 1710–11, pl lxiii, figs 1 *a–k*, 3 *c*

Paramæcium caudatum, Schewiakoff, 1893, p 52 , 1894, pp 39–56, pl iii, figs 1–8 , 1896, pp 340–1, pl v, fig 127 , pl vii, figs 169–70, 187, 192, 202–3

Paramecium caudatum, Roux, 1901, p 68, pl iv, fig 4 , Schuberg, 1905, pp 70–2, 93–7, 102–4

Paramæcium caudatum, Khainsky, 1911, pp 1–60, pls i–iii & 2 text figs

Paramecium caudatum, Woodruff, 1911 *b*, pp 223–37

†*Paramæcium caudatum*, Bhatia, 1916, p 183, 1923, pp 69–72
†*Paramœcium caudatum*, Ghosh, 1921 *a*, p 10, Thapar & Chaudhury, 1923, pp 64–8
Paramecium caudatum, Dembowski, 1923, pp 25–54, pls ii, iv, & 3 text-figs, Bozler, 1924, pp 163–215, pl viii & 10 text figs, Lepsi, 1926 *a*, p 58, fig 230, Calkins, 1926, pp 53, 162, 496 figs 21, 85, 206, Wenyon, 1926, pp 26, 79, 131, figs 29, 45 70, Schoenichen, 1927, p 211, pl xii, fig 40, Wenrich, 1928, p 279, pl xxxvi, fig 2
Paramæcium caudatum, Reichenow, 1929, p 1176, fig 1160 A
†*Paramecium caudatum*, Bhatia & Mullick, 1930, p 396
Paramecium caudatum, Kahl, 1930–5, p 291, fig 48, *1*, *2*

Body elongated, cylindrical, but somewhat flattened, at least three times as long as broad, anterior end broader and rounded, posterior end gradually tapering and usually provided with a tuft of longer cilia Trichocysts abundantly present Contractile vacuoles two, stellate, situated about one-third or one-fourth the length of the body from either end Macronucleus egg-shaped, with a single compact micronucleus lying close by it One of the commonest species in standing water

Dimensions —Length 120–330 μ, usually 200–300 μ

Remarks —Very common at all times of the year in stagnant water and in infusions of dry leaves Examples also grow well in a mucilage of *Ispaghul*-seeds, and their movements are rendered slow After being kept in this medium for two or three days, owing to the colouring matter of the seeds diffusing into the water, the nuclei and food-particles are found to be stained a beautiful reddish colour in the living animals

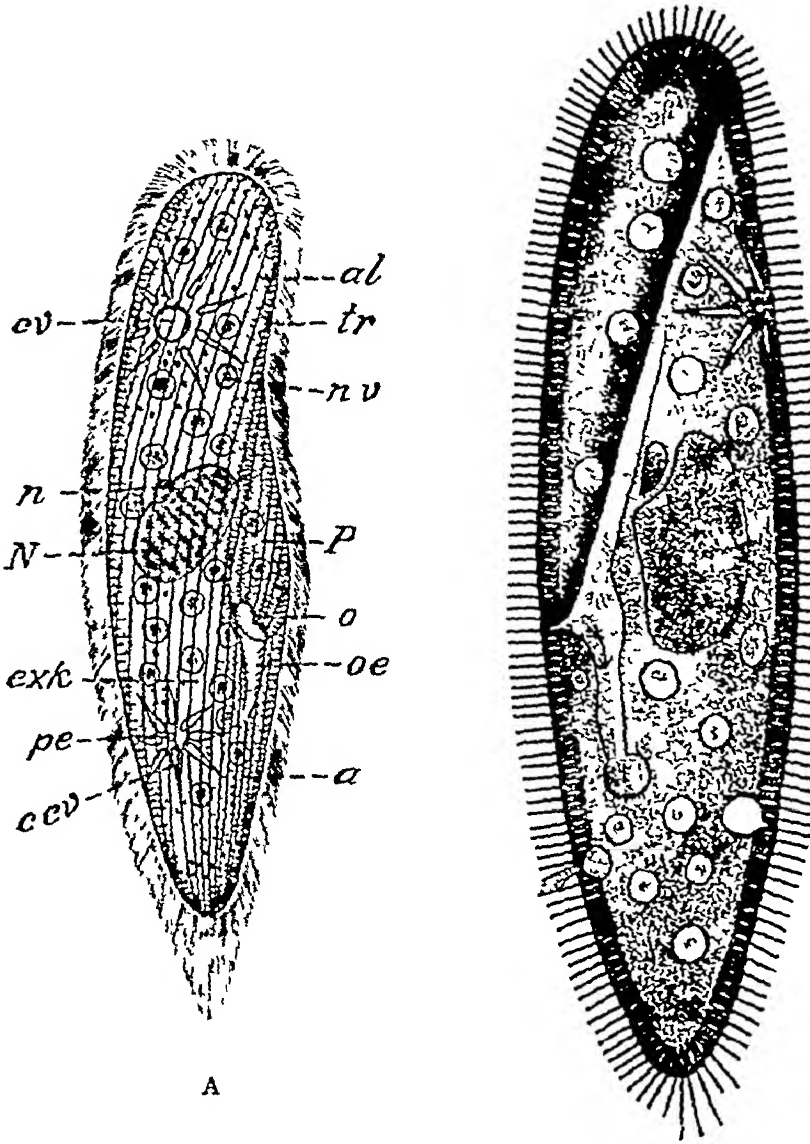
The tuft of longer cilia usually described at the posterior end is generally not present in forms met with at Lahore. Bhatia (1916) found extra contractile vacuoles in this species, and discussing the significance of this (1923) suggested that the occasional occurrence of extra vacuoles in *Paramecium* is a case of reversion to an ancestral condition in which there may have been a continuous row of vacuoles, as is so often the case, for example, in certain species of *Enchelis*, *Loxophyllum*, *Dileptus* and *Chilodon* among GYMNOSTOMATA, and in several species of *Anoplophrya* and of other genera among ASTOMATA The evolution of the radiating canals which drain a large area of cytoplasm may possibly have been the cause of the number becoming restricted to two Dimitrowa (1928) and Lepsi (1929) have supported the view

Habitat —Pond water KASHMIR, Srinagar, PUNJAB, Lahore, UNITED PROVINCES, Lucknow, BENGAL, Calcutta

81 **Paramecium** sp

Paramœcium sp, Simmons, 1891, p 4

Habitat —Pond water BENGAL, Calcutta



A

B

Fig 65 —A *Paramecium caudatum* Ehrbg *a*, anus, *al*, alveolar layer, *cv*, contractile vacuole, *ccv*, radiating canal, *exk*, excretory granules, *N*, macronucleus, *n*, micronucleus, *o*, cytostome, *oe*, cytopharynx, *P*, peristomial groove, *pe*, excretory pore, *tr*, trichocysts (After Schewiakoff) B *Paramecium caudatum* Ehrbg, showing micronuclear structure (After Wenrich)

4. Family TRICHOPELMIDÆ Kahl, 1931 (=LEPTOPHARYNGIDÆ Kahl, 1926).

Small forms without test, generally strongly flattened laterally, with delicate pellicle resembling a coat-of-mail Cilia sparse, particularly on the right flattened side, where they form a semicircular or sickle-shaped uninterrupted dorsal keel, and 2 to 9 interrupted rows of cilia on the plane surface Cytostome on the compressed ventral surface, membranoid structures recognizable with difficulty

Genus **DREPANOMONAS** Fresenius, 1858 (=DREPANOCEROS Stein, 1878)

Drepanomonas, Fresenius, 1858, p 216, Bütschli, 1887–9, p 1710, Penard, 1922, p 167, Lepsi, 1926*a*, p 48, Kahl, 1930–5, p 304

Small to very small, very flattened, narrowly sickle-shaped or half-moon-shaped Right margin keel-shaped, uniformly curved in a sickle-shaped manner or more elongated and broadly rounded at both anterior and posterior ends. Left margin elongated and slightly concave Oral field small, groove-like, with small membranelle in the middle of the left margin, a cytopharynx observed in two species Ventral surface with three ciliary rows, the two left ones interrupted in the middle, dorsal surface with only two ciliary rows or isolated cilia In the oral groové or behind it are some isolated cilia Often there is a deep longitudinal furrow on the dorsal surface Contractile vacuole and macronucleus in the middle region of the body

82 **Drepanomonas dentata** Fresenius (Fig 66)

Drepanomonas dentata, Fresenius, 1858, pp 216–17, pl x, figs 25–8
Litonotus fasciola (young condition), Kent, 1880–2, p 744
Drepanomonas dentata, *Butschli, 1887–9*, pl lxiv, *fig 14*, *Mermod*, 1914, p 70
†*Drepanomonas dentata*, Ghosh, 1920 *a*, pp 145–6, fig 2, 1921 *a*, p 10, fig 8
Drepanomonas dentata, Penard, 1922, pp 167–8, fig 165, Lepsi, 1926 *a*, p 53, figs 167, 168, Kahl, 1930–5, p 304, fig 50, *11*, *12*

Body semilunar, laterally compressed, convex dorsally, concave on the ventral border, sharply pointed at either end The ventral border bears in the middle a depression in which lies the cytostome, provided with a small undulating membrane On each lateral surface there are two longitudinal ciliated

grooves which meet behind and lose themselves anteriorly in characteristic denticulations A small contractile vacuole, with accessory vacuoles, close to the angle of the buccal depression Macronucleus spherical, situated a little behind or above the mouth On *Sphagnum* and in marshy water

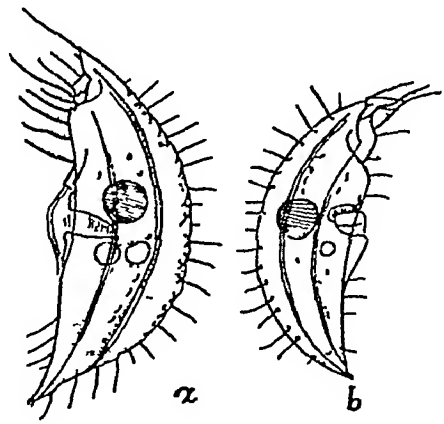


Fig 66 —*Drepanomonas dentata* Fres
a, left lateral aspect, *b*, right lateral aspect (After Penard)

Dimensions —Length 40–65 μ.

Remarks —The form met with by Ghosh differed from the typical condition in that the dentations were broader and less numerous, anterior end was rounded, without forming a beak, there was a second oblique ridge on the surface near the postero-lateral margin, and cytopharynx was narrow and comparatively long Measurements are not given, and the figure given is very crude

Habitat —Vegetable infusions BENGAL, Calcutta

INCERTÆ SEDIS

Genus **OPISTHOSTOMUM** Ghosh, 1928

Body oval Peristome narrow, postero-terminal, surrounded by a large ventral lobe, a large left dorso-lateral lobe, and a small right dorso-lateral lobe A single sinuous row of well-developed membranelles in the peristome

83 **Opisthostomum bengalense** Ghosh (Fig 67)

†*Opisthostomum bengalensis*, Ghosh, 1928, p 383, figs 2, 3
Opisthostomum bengalense, Kahl, 1930–5, p 311, fig 49, *13*

Body elongately and irregularly oval, less than twice as long as broad, broadly oval in transverse section Anterior

end somewhat tapering and rounded Posterior end with three lobes—a large ventral lobe, a somewhat triangular lobe on the dorso-lateral aspect and to the left, and a narrow elongated lobe on the right side somewhat projecting on the dorsal aspect Peristome a long narrow excavation, apparently naked, a row of well-developed membranelles Body uniformly ciliated, cilia on the left side very long Macronucleus large, oval, and placed in the posterior half of the body Micronucleus spherical, on the right side of the macronucleus

Dimensions —Length 78μ, width 48μ

Fig 67 —*Opisthostomum bengalense* Ghosh (After Ghosh)

Remarks —Ghosh has referred the genus to HETEROTRICHA, to which it has no relationship Kahl thinks that the form is much more related to *Mycterothrix*, family Marynidæ He thinks that Ghosh has described the peristome as postero-terminal with reference to the direction of the swimming of the organism, but that it is really at the anterior pole, and the animal swims backwards, as does *Mycterothrix* The form requires further study before its correct position can be determined

Habitat —Sewer water BENGAL, Calcutta

5 Family ISOTRICHIDÆ Butschli, 1889.

Body with thick pellicle, and with a general and dense covering of cilia Cytostome ventral, near the posterior end Commensals or parasites in the rumen of Ruminantia

Key to Indian Genera

1 Body with rounded posterior and more pointed anterior end Macronucleus with a nuclear stalk	ISOTRICHA St, p 156
2 Body more regularly ovoid Macronucleus without a nuclear stalk	DASYTRICHA Schub, [p 158

Genus ISOTRICHA Stein, 1858

Isotricha, Stein, 1858, p 69, 1861, p 85, Kent, 1880–2, p 497, Schuberg, 1888, p 377, Bütschli, 1887–9, p 1715, Schewiakoff, 1896, p 373, Hickson, 1903, pp 401, 403, Minchin, 1912, p 439, Hegner & Taliaferro, 1924, p 385, Calkins, 1926, p 407, Wenyon, 1926, p 1191, Knowles, 1928, p 523, Reichenow, 1929, p 1177, Kudo, 1931, p 368

Body somewhat flattened, ovoid, with rounded posterior and more pointed anterior ends, uniformly covered with cilia Cytostome at the end which is posterior in locomotion or laterally placed Contractile vacuoles many, distributed superficially in the central region of the body Anal aperture at the anterior end Macronucleus large, elongate, lying longitudinally in the posterior region or in the middle of the body, in a bag attached by a nuclear stalk Micronucleus oval, close to the macronucleus Parasitic in the rumen of cattle and sheep

Remarks —It is a matter of definition whether to refer to the cytostomial end as anterior or posterior Butschli (1887–9) and other authors, including Reichenow (1929), speak of the cytostome as situated at the posterior end and the animal swimming with the anterior end foremost Others, including Wenyon (1926), regard the oral end as anterior and the animal as habitually swimming backward

Key to Indian Species

1 With cytostome at the posterior end of the body	*I prostoma* St, p 157
2 With cytostome lateral, at some distance from the posterior end	*I intestinalis* St, [p 158

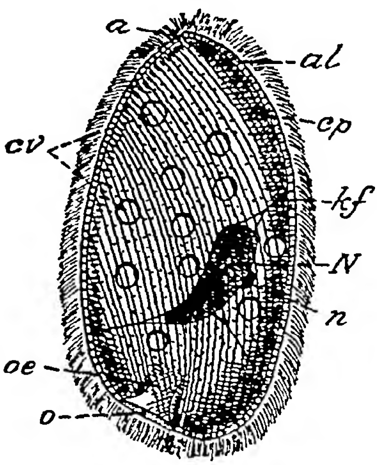
84 **Isotricha prostoma** Stein (Fig 68)

Isotricha prostoma, Stein, 1858, p 88, Kent, 1880–2, p 497, Schuberg, 1888, pp 377–85, pl xii, figs 4–5, pl xiii, figs 10–13, Bütschli 1887–9, pl lxv, fig 12, Schewiakoff, 1896, p 375, pl. vi, fig 142, Braune, 1913, p 139, Hegner & Taliaferro, 1924, p 385, Knowles, 1928, fig 132, *13*, Reichenow, 1929, p 1177, fig 1162, Campbell, 1929, pp 331–9, pls x–xii, 1930, pp 141–6, pls xi, xii, Kudo, 1931, p 368, fig 159 *a*
†*Isotricha prostoma*, Kofoid & MacLennan, 1933, p 28, Kofoid & Christenson, 1934, p 377, Das Gupta, 1935, p 159

Form very flexible and elastic, but not contractile Body elongated ovoid, with one end rounded and the other pointed The body is somewhat flattened dorso-ventrally and is covered with cilia Cytostome, with a short wide

Fig 69

Fig 68



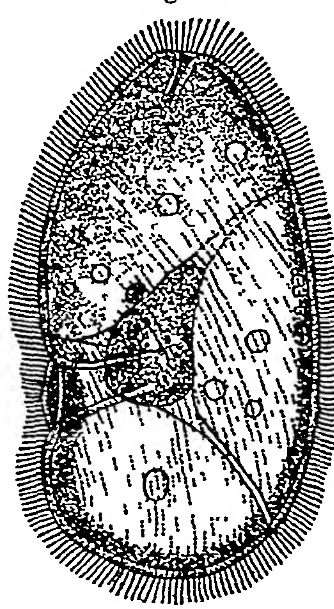


Fig 68—*Isotricha prostoma* Stein *a*, anus, *al*, alveolar layer, *cp*, pellicle, *cv*, contractile vacuoles, *kf*, nuclear stalk, *N*, macronucleus, *n*, micronucleus, *o*, cytostome, *oe*, cytopharynx (After Schewiakoff)
Fig 69—*Isotricha intestinalis* Stein (After Eberlein)

cytopharynx provided with stronger cilia, situated at the end of the body, which is posterior in locomotion Contractile vacuoles many, distributed superficially in the central region of the body. Anal aperture at the end which is forward in locomotion Macronucleus large, elongate, lying longitudinally in the posterior region of the body in a bag attached

by a nuclear stalk to the wall of the organism Micronucleus oval, close to the macronucleus Parasitic in the rumen of cattle and sheep

Habitat—In the stomach of *Bos indicus* Linn (locality not given), stomach of *Bos gaurus* H Smith Mysore, rumen of *Capra hircus* Linn BENGAL, Calcutta

85 **Isotricha intestinalis** Stein (Fig 69)

> *Isotricha intestinalis*, Stein, 1858, p 69, Kent, 1880-2, p 497, Schuberg, 1888, pp 385-6, pl xiii, figs 14-16, Butschli, 1887-9, pl lxv, figs 10, 11 Hickson, 1903, pp 401-3
> †*Isotricha intestinalis*, Jameson, 1925, p 400
> *Isotricha intestinalis*, Wenyon, 1926, p 1191, fig 504, 5, Reichenow, 1929, p 1178
> †*Isotricha intestinalis*, Kofoid & Christenson, 1934, p 377

Body obovate, slightly flattened, longitudinally striate Cytostome ventral, situated within a semilunar depression at some distance from the posterior end, and provided with a short cytopharynx Cilia long, fine Contractile vacuoles numerous, distributed chiefly in the posterior region Macro nucleus elongate oval, with a small, rounded micronucleus close to it The whole nuclear apparatus is contained within a bag attached by a nuclear stalk to the inner layer of the cytoplasm Dimensions not recorded

Remarks—This species was present in fair numbers in material from Ceylon, and the shape was markedly more rounded than is usually the case

Habitat—In the stomach of *Tragulus meminna* Milne Edwards (mouse deer) CEYLON, stomach of *Bos gaurus* H Smith Mysore

Genus **DASYTRICHA** Schuberg, 1888

> *Dasytricha*, Schuberg, 1888, p 386, Bütschli, 1887-9, p 1716, Schewiakoff, 1896, p 376, Hickson, 1903, p 403, Braune, 1913, p 145, Wenyon, 1926, p 1191, Calkins, 1926, p 407, Reichenow, 1929, p 1178, Kudo, 1931, p 369

Body more regularly ovoid than in *Isotricha* Macro nucleus without a nuclear stalk Parasitic in the rumen of cattle and sheep

86 **Dasytricha ruminantium** Schuberg (Fig 70)

> *Dasytricha ruminantium*, Schuberg, 1888, pp 386-91, pl xiii, figs 17-20, Schewiakoff, 1896, p 377, pl vi, fig 144
> *Isotricha ruminantium*, Braune, 1913, p 130

Isotricha (Dasytricha) ruminantium, Dogiel, 1925 *b*, p 286
Dasytricha ruminantium, Wenyon, 1926, p 1191, fig 504, *9*
Isotricha (Dasytricha) ruminantium, Dogiel & Fedorowa, 1927, pp 75–82, figs 1–11
Dasytricha ruminantium, Reichenow, 1929, p 1178, Kudo, 1931, p 369, fig 159 c
†*Dasytricha ruminantium*, Kofoid & MacLennan, 1933, p 28, Kofoid & Christenson, 1934, p 377, Das-Gupta, 1935, p 159

Body regularly ovoid, uniformly covered with cilia Cytostome at the posterior end of the body leading to a curved cytopharynx Contractile vacuole single Anal aperture at the anterior end of the body Macronucleus a small, curved body, without a nuclear stalk Micronucleus lying close to the macronucleus

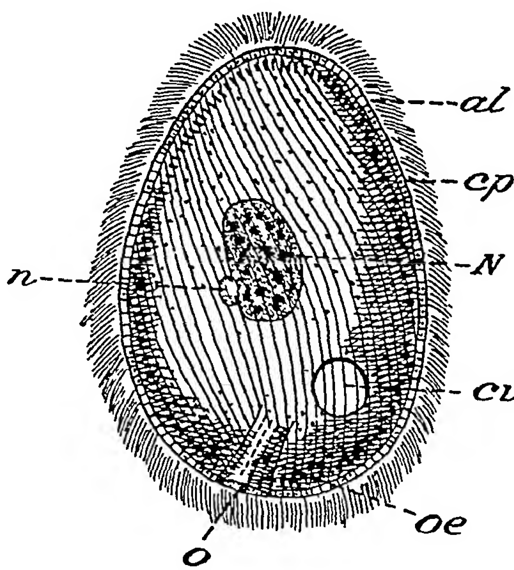


Fig 70—*Dasytricha ruminantium* Schub *al*, alveolar layer, *cp*, pellicle, *cv*, contractile vacuole, *N*, macronucleus, *n*, micronucleus, *o*, cytostome, *oe*, cytopharynx (After Schewiakoff)

Dimensions—Length 50–110 μ, width 25–65 μ

Remarks—Dogiel and Fedorowa (1927) have published a note on the reproduction in this species, and have referred it to the genus *Isotricha*

Habitat—In the stomach of *Bos indicus* (locality not given), stomach of *Bos gaurus* H. Smith Mysore, rumen of *Capra hircus* Linn BENGAL, Calcutta

6 Family BLEPHAROCORIDÆ Hsiung, 1829

Body ciliation confined to certain regions only, tufts of cilia situated above and below the cytostome, and in the posterior anal region Cytostome not terminal and not lying in a prominent depression Contractile vacuole single, posterior Macronucleus and micronucleus central Parasites in the Ungulate Mammals

Genus **BLEPHAROCORYS**, Bundle, 1895

Blepharocorys, Bundle, 1895, pp 305–9
Charon, Jameson, 1925, p 403 , Wenyon, 1926, p 1193
Blepharocorys, Dogiel, 1926, pp 61–4 , 1934, p 297
Charonella, Bhatia, 1935, p 13

Body with a simple anterior projection and with an anterior and a posterior group of cilia, the posterior cilia in one or two compact bundles The cytostome does not lie in a prominent depression, and opens into a cytopharynx which extends deep into the body Attached to the left side of the cytopharynx is a well-developed ciliary membrane made up of stout cirri No permanent anal opening Contractile vacuole single, large, in the posterior part of the body Macronucleus large, rounded and coarsely granular Micronucleus oval and close to the macronucleus In the paunch and rumen of cattle and sheep

Remarks —Jameson described *Charon* as a new genus, but that name being pre-occupied for an Arachnid genus of Karsch (1879), I changed the name to *Charonella* Dogiel (1934) has, however, pointed out that *Charon ventriculi* Jameson and *Blepharocorys bovis* Dogiel are identical, and the form should be called *Blepharocorys ventriculi* (Jameson)

87 **Blepharocorys ventriculi** (Jameson) (Fig 71)

Charon ventriculi, Jameson, 1925*a*, pp 403–5, 1 fig , Wenyon, 1926, p 1193
Blepharocorys bovis, Dogiel, 1926, pp 61–4, 1 fig
†*Charon ventriculi*, Kofoid & MacLennan, 1933, p 28
Blepharocorys ventriculi, Dogiel, 1934, p 297

Body resembles the blade of a lancet, with one side convex the other nearly straight, more than twice as long as broad, very much compressed dorso-ventrally Anterior end bluntly pointed and pinched into a projecting knob , the posterior end tapers to a finer rounded point Ventral surface flat or very slightly concave , dorsal surface very slightly convex ,

right side straight, left side convex Anterior end of the body covered with many cilia, including two tufts of cilia similar to those of posterior end, but less prominent The anterior and posterior pairs of ciliary bundles consist of stiff, long cirri, which are only capable of bending near the tips The anterior bundles are placed, one on each side of the body, at the base of the anterior knob on a level with the cytostome The posterior bundles lie one on each side of the body, close to the end, and each is inserted in an oval socket The posterior bundles are chiefly locomotory, moving in unison with slow, somewhat jerky strokes Cytostome round or slightly pear-shaped, situated on the ventral surface of the body immediately behind the anterior ciliated

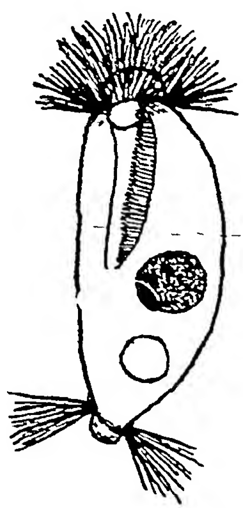


Fig 71 —*Blepharocorys ventriculi* (Jameson) (After Jameson)

tip, and opens at once into a prominent cytopharynx Cytopharynx extends deep into the body, reaching at least halfway to the posterior end, and curving slightly to the right Extending along the whole length of the left side of the cytopharynx is a well-developed ciliary membrane, made up of stout cirri, which seem to be fixed together and act as an undulating membrane Contractile vacuole single, large, in the posterior part of the body No permanent anal opening, but occasionally a temporary anus can be seen opening at the extreme posterior tip of the body Macronucleus large, rounded, coarsely granular in structure, usually situated about the middle, near the end of the cytopharynx

Micronucleus oval, lying in a depression in the macronucleus or close to it Feeds on bacteria and fine organic particles

Dimensions —Length 24–36 μ, breadth 12–15 μ

Habitat —Very rare in the stomach of *Bos indicus* (locality not given)

3. Suborder *HYMENOSTOMATA* Hickson, emend Kahl

HOLOTRICHA in which the mouth is permanently open, and provided with membranes, formed by the fusion of rows of cilia, and free cilia in addition

Remarks —Previously the terms TRICHOSTOMINA and HYMENOSTOMATA were indiscriminately used to include all HOLOTRICHA in which the mouth was provided either with free cilia or with some of the cilia united to form membranes Kahl (1926, 1930–5) has grouped these forms into two sub orders, TRICHOSTOMATA (oral cilia free) and HYMENOSTOMATA (oral cilia united to form membranes) Reichenow (1929) has followed him in this usage of these terms

Identification Table of Families

1	(2)	Oral aperture without a peristome	**Frontoniidæ** Kahl, [p 163
2	(1)	Oral aperture lies at the end or the bottom of a peristome	3
3	(12)	Ciliation on all sides or limited to the oral side	4
4	(5)	Peristome runs as sickle shaped ciliated cleft, perpendicular to the surface of the body, into the depressed oral aperture An hour-glass-shaped body lies in front of the anterior end of the peristomial cleft	**Ophryoglenidæ** Kent, [p 180
5	(4)	Peristome extends along the surface of the body from the anterior pole to the oral aperture	6
6	(9)	Peristome bears an undulating membrane along one border	7
7	(8)	Peristome runs from the truncated anterior end of the body to the small cytostome situated in the anterior third of the body Peristome bears an undulating membrane along its left border	**Sagittariidæ*** Grandori
8	(7)	Peristomial plate bears along the right border an undulating membrane which surrounds the hinder margin of the oral aperture like a pocket Left peristomial border bears a ciliary row or membrane	**Pleuronematidæ** Kent, [p 182
9	(6)	Peristome differently provided	10

10 (11)	Right peristomial border with two undulating membranes Ectoplasmic pocket surrounding the cytostome absent	Cohnilembidæ * Kahl
11 (10)	Peristomial groove provided along the right border either with a dense ciliary field, besides the undulating membrane, or only a thick undulating membrane To the right of the cytostome, or surrounding it behind, is a pocket sunk below the ectoplasm with a small membrane	Philasteridæ * Kahl
12 (3)	Ciliation reduced to two broad ciliary girdles	[Lachm , p 189 Urocentridæ Clap &

1 Family FRONTONIIDÆ Kahl, 1926 (=CHILIFERA Butschli).

Body ovoidal, uniformly ciliated, without a peristome Cytostome situated in the anterior half of the body, at the end of an open groove or of a hooded funnel Oral groove provided with one or more membranes and free cilia, arranged in a variety of ways Contractile vacuole single, usually central Macronucleus single or double, central

Key to Indian Genera

1 (16)	Posterior end without a caudal bristle	2
2	Cytostome not followed by a funnel-shaped cytopharynx, or cytopharynx, if present, without undulating membrane or cilia	3
3 (6 or 8)	Oral aperture anteriorly pointed, posteriorly transversely truncated	4
4 (5)	Cytostome along the right border, near the end of the body membrane in the right oral margin	TRICHODA, p 168
5 (4)	Cytostome on the ventral surface, large undulating membrane in the left oral margin A postoral seam running to the posterior pole, no striated band on the dorsal surface posteriorly Body not narrowed behind in a uniformly triangular manner	FRONTONIA, p 164
6 (3)	Oral aperture not transversely truncated behind, but obliquely pointed or rounded	7
7	Cytostome a small sigmoid cleft, removed from the anterior pole, with two membranes	SIGMOSTOMUM, p 167
8 (3)	Oral aperture anteriorly rounded or truncate	9

9 (14)	Cytostome obliquely placed, from right anterior to left posterior direction, the right margin with a projecting ectoplasmic lip Inside the cytostome are three ciliary structures, an outer membrane on the left, beneath that an inner, and to the right at the bottom a three rowed ciliary band	10
10 (11)	Cytostome near the middle of the ventral surface, dorsal series of cilia not strikingly bent to the right anteriorly	GLAUCOMA, p 170
11 (10)	Cytostome lying in the right border of the body	12
12 (13)	Dorsal series of cilia bend anteriorly more or less obliquely to the right	COLPIDIUM, p 173
13 (12)	Only one strong membrane extends from the left margin into the upper, concave, ectoplasmic lip Small, contractile, in damp moss, or marine	PSEUDOGLAUCOMA, [p 176
14 (9)	Oral aperture without the ectoplasmic lip on the right, cytostome with only one membrane	15
15	Membrane inserted in the left and anterior margin and encloses the mouth in a cap like manner	STEGOCHILUM p 178
16 (1)	Posterior end with a caudal bristle Ciliation uniform, anterior pole with unciliated frontal plate From the anterior end an indistinct furrow runs to the mouth, bearing somewhat strong cilia along its right border	URONEMA, p 178

Genus FRONTONIA Ehrenberg, 1838, emend Claparede & Lachmann

Qursaria, part, Ehrenberg, 1838, p 325
Ophryoglena, part (*acuminata* and *atra*), Ehrenberg, 1838, p 360
Frontonia subgenus, Ehrenberg, 1838, p 329
Panophrys, Dujardin, 1841, p 491
Cyrtostomum, Stein, 1859 *a*, p 59, 1859 *d*, pp 63, 82, 87, 1867, pp 67, 69, 92, 123
Frontonia, Claparède & Lachmann, 1858–61, pp 259–60, Fromentel, 1874, p 190
Cyrtostomum, Kent, 1880–2, pp 496–7
Frontonia, Bütschli, 1887–9, p 1703, Schewiakoff, 1896, p 309, Roux, 1901, p 59, Hickson, 1903, p 402, Minchin, 1912, p 439, Calkins, 1926, p 406, Lepsi, 1926 *a*, p 50, Schoenichen, 1927, p 205, Reichenow, 1929, p 1179, Kahl, 1930–5, p 316

Body elongated, cylindrical, more or less flattened, rounded at both ends, the posterior end being somewhat narrower Dorsal surface convex, ventral flat Right border straight or slightly concave, left border convex Cilia long, fine, arranged along longitudinal lines Oral fossa lies in the anterior third of the ventral surface, to the right of the median line, oval in form, the long axis antero-posterior, sharply

pointed in front and broadly truncated behind. The left border of the oral fossa is more strongly curved and provided with a large undulating membrane, composed of three lamellæ and four rows of cilia the right border with cilia, inner shorter cilia membranoid and united, and the outer three rows of free cilia extending beyond the cytostome to the postoral groove, which extends towards the posterior end of the body Contractile vacuole single, central, with or without radiating canals Macronucleus ellipsoidal, central, obliquely placed, with numerous micronuclei attached to it Body often filled with algæ and diatoms Locomotion quick, the animal rotating on its long axis and often changing its direction

88 **Frontonia leucas** (Ehrenberg) (Fig 72, A & B)

Bursaria leucas, Ehrenberg, 1838, p 329, pl xxxiv, fig 8
Frontonia vernalis, Ehrenberg, 1838, p 329, pl xxxiv, fig 7
Panophrys (*Bursaria*) *leucas*, Dujardin, 1841, p 494
Panophrys (*Bursaria*) *vernalis*, Dujardin, 1841, p 492, pl xiv, fig 7
Panophrys chrysalis, Dujardin, 1841, p 492, pl xiv, fig 7
†*Bursaria leucas*, Carter, 1856 *b*, pp 115–32, 248, pl vii, fig 85
Frontonia leucas, Claparède & Lachmann, 1858–61, pp 259–60
Cyrtostomum leucas, Stein, 1859 *a*, p 59, 1859 *d*, pp 63, 82, 87, 1867, pp 67, 69, 92, 123
Panophrys (*Bursaria*) *leucas*, Stein, 1867, p 44
Panophrys (*Bursaria*) *vernalis*, Stein, 1867, p 44
Frontonia leucas, Fromentel, 1874, p 190
Cyrtostomum leucas, Kent 1880–2, p 497, pl xxvi, fig 37, Fabre-Domergue, 1888, pp 13–18, pl ii, figs 16–21, Balbiani, 1888, pp 23–55, pl i, figs 1–12, Maupas, 1889, p 786
Frontonia leucas, Butschli, 1887–9, p 1703, pl. lxii, fig 3, *a–c*, Schewiakoff, 1889, pp 38–41, pl v, figs 57–64, 1893, p 45, 1896, pp 312–13, pl v, fig 113, pl vi, fig 164, pl vii, figs 173, 177, 191 & 201, Roux, 1901, pp 59–60, pl iii, fig 13, Penard, 1922, pp 131–9, figs 132–6, Lepsi, 1926 *a*, p 57, fig 179, Calkins, 1926, p 158, fig 83, Schoenichen, 1927, p 205, pl xii, fig 29, Reichenow, 1929, p 1179, fig 1165
†*Frontonia leucas*, Bhatia & Mullick, 1930, pp 396–8, fig 3
Frontonia leucas, Kahl, 1930–5, p 317, fig 55, *1*

Body elongated, rounded at both extremities, wider anteriorly and narrower posteriorly Posterior end slightly pointed, with few longer cilia Right border straight or slightly concave, left border convex Cilia long, fine, and arranged along longitudinal lines, the lines of the right side meeting those of the left in front of the mouth Oral fossa oval, lying in the anterior third of the ventral surface, the post-oral groove extending to the posterior part of the body Contractile vacuole single, situated about the middle near the right border, with long radiating canals Macronucleus ellipsoid, granular, and with several micronuclei Colourless or brownish, or often green on account of contained zoochlorellæ

Dimensions —Size very variable, from 150–600 μ

Remarks —The length of the specimens found at Srinagar varied from 200 to 324 μ The living specimens were quite opaque and nothing could be made out except the contractile vacuole with its radiating canals and the large number of algal filaments on which the organisms had fed In specimens properly fixed and stained with iron hæmatoxylin the detailed structure of the oral fossa could be made out (Penard, 1922, Bhatia & Mullick, 1930)

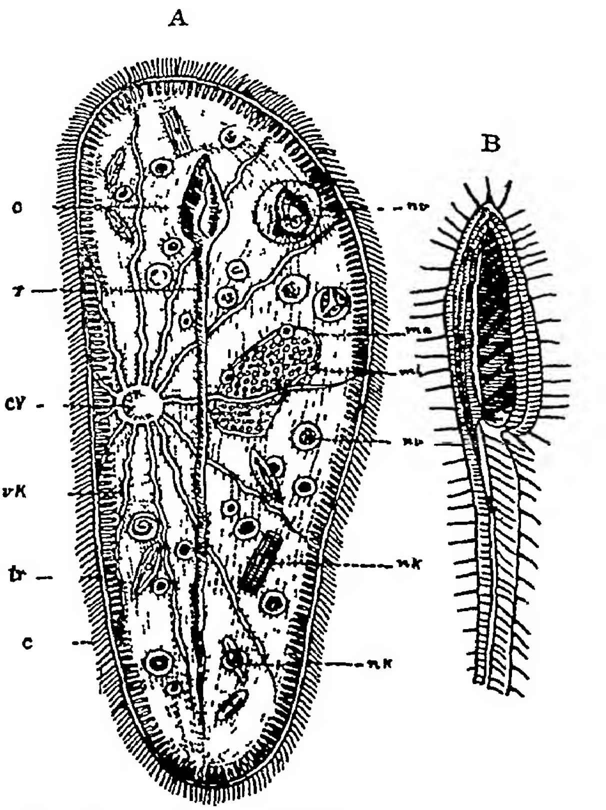


Fig 72 —A *Frontonia leucas* (Ehrbg) *c*, cilia, *cv*, contractile vacuole, *ma*, macronucleus, *mi*, micronucleus, *nk*, food particles, *nv*, food-vacuoles, *o*, cytostome *r*, pharyngeal groove, *tr*, trichocysts, *vk*, radiating canal (From Reichenow, after Tonniges) B Oral field of *Frontonia leucas* (Ehrbg) (After Bhatia and Mullick)

The oral fossa (fig 72, B) is oval, being pointed at its anterior end and elongated in the direction of the animal From the base of this oral fossa on the right side a longitudinal furrow or seam extends almost to the posterior end of the body The fossa is ornamented by cilia, which are enlarged at their

points of attachment and are free at their distal extremity, in addition a broad, striated lamella is attached to the left, and a long and narrow undulating membrane to the right border of the framework On the right side of the fossa are three parallel striated bands, separated by lines of small and close-set basal granules from which the cilia arise The innermost band also bears longer cilia along its left border, and, in addition, gives attachment to the long, narrow, undulating membrane, referred to above, this extends along the whole length of the oral fossa, but stops at the commencement of the postoral or pharyngeal groove, which runs along the ventral side of the animal almost to the posterior end of the body

Along the left margin of the oral fossa are two striated bands At the anterior end of the fossa there seem to be three such bands, making an acute angle with those of the right side, but only two of the bands extend along the left border At the base of the oral fossa the outer one stops, while the inner is curved and continued to form the wall of the pharyngeal groove The inner band bears along its right border a number of thick lashes, as shown in the figure To this border is also attached a broad, transversely striated membrane, which extends across and covers the oral fossa This membrane is free at its right border, and thus leaves uncovered a narrow groove, which is continued behind as the pharyngeal groove

Trichocysts are abundantly distributed all over the body in the cortical region Penard has described a large variety of trichocysts in this species, but Bhatia and Mullick recognized only three kinds, viz, (1) a spherical form of trichocysts lying close to the border of the oral fossa, (2) fusiform, and (3) somewhat curved, rod-like trichocysts, distributed all over the surface

The large macronucleus is ellipsoidal and situated in the middle of the body It is granular in structure There are numerous micronuclei lying over the macronucleus Each of these is an elongated oval body, with a strong nuclear membrane, and a single dense body inside

Habitat —Clear standing water KASHMIR, Srinagar, fresh water BOMBAY, Bombay

Genus SIGMOSTOMUM Gulati, 1925

Sigmostomum, Gulati, 1925, p 751, Kahl, 1930–5, p 322, Calkins, 1933, p 505

Form, position of the contractile vacuole and the cytostome as in *Frontonia* Cytostome is a sigmoid cleft with a membrane along each margin Ectoplasm with trichocysts arranged in a honeycomb-like manner Macronucleus oval, with a single micronucleus Feeds on algal filaments

89 **Sigmostomum indicum** Gulati (Fig 73)

†*Sigmostomum indicum*, Gulati, 1925, p 751, pl ii, fig 20
Sigmostomum indicum, Kahl, 1930–5, p 322

Body oval, about three times as long as broad, anterior end a little broader than the posterior end Cilia evenly distributed all over the body Trichocysts well developed Cytostome ventral, in the anterior half of the body, an S-shaped slit lined by undulating membranes on both lips No peristomial field leading to the cytostome Cytopharynx absent Contractile vacuole single, spherical, central Macronucleus oval, in the posterior half of the body, and granular in structure Micronucleus small, oval, lying by the side of the macronucleus Locomotion swift, restlessly rotating on its own axis Feeds on large filamentous algæ

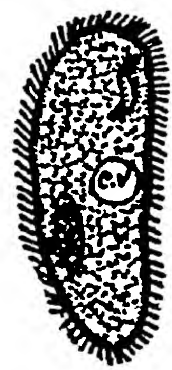


Fig 73 —*Sigmostomum indicum* Gulati c v, contractile vacuole (After Gulati)

Dimensions —Length 145 μ, width 42 μ

Remarks —Kahl thinks that Gulati's examples were, in all probability, specimens of *Frontonia leucas*, but I do not agree with him, as there were no indications of either a postoral seam, the special structures in the oral fossa, or the radiating canals connected with the contractile vacuole, which Gulati could not have missed

Habitat —Pond water PUNJAB, Lahore

Genus **TRICHODA** O F Muller, 1773

Trichoda, O. F Müller, 1773, p 71, Ehrenberg, 1838, p 306 Kent, 1880–2, p 535
Glaucoma, part, Butschli, 1887–9, p 1702
Trichoda, Schoenichen, 1927, p 204

Animalcules free-swimming, very small, elastic, but more or less persistent in shape, ovate or pyriform Cytostome

situated near the pointed and obliquely truncated anterior extremity, approached by an ovate oral fossa the right margin of which gives attachment to a single, vibratile, flap-like membrane Cuticular surface finely ciliate throughout, a circlet of larger cilia surrounding the entrance to the oral fossa Especially abundant in putrid infusions

90 **Trichoda pura** Ehrenberg (Fig 74)

Trichoda pura, Ehrenberg, 1838, p 307, pl xxxi, fig xi, Kent, 1880–2, p 535, pl xxvii, fig 47
Glaucoma pura, Butschli, 1887–9, p 1702
†*Trichoda pura*, Bhatia, 1916, p 182
Trichoda pura, Schoenichen, 1927, p 204
Glaucoma sp, Sandon, 1927, p 181

Body pyriform, rounded posteriorly, tapering gradually towards the anterior extremity Cytostome at the anterior

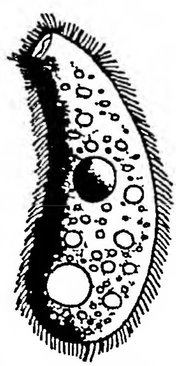


Fig 74 —*Trichoda pura* Ehrbg (After Kent)

extremity Oral fringe of cilia conspicuous, those of the general cuticular surface very fine Contractile vacuole located posteriorly Macronucleus single or double, spherical, subcentral In pond water and vegetable infusions

Dimensions —Length up to 40μ

Remarks —The animalcules were found in large numbers in an infusion of hay Two specimens measured 32μ by 16μ and 38μ by 22μ respectively The cytostome was near the anterior end but not terminal, the oral fossa was more or less oval, with a single quivering membrane on the right side attached to the posterior outer angle of the fossa and sometimes springing out of it

Habitat —Hay infusions PUNJAB, Lahore.

Genus **GLAUCOMA** Ehrenberg, 1830

Glaucoma, Ehrenberg, 1830, p 42, 1838, p 334, Dujardin, 1841, p 475, Stein, 1854, p 250, 1859*d*, p 74, 1867, pp 92, 123, Claparède & Lachmann, 1858–61, p 277, Fromentel, 1874, p 188, Kent, 1880–2, p 795, Butschli, 1887–9, p 1702, Roux, 1901, p 54, Hickson, 1903, p 402, Minchin, 1912, p 439, Calkins, 1926, p 406, Lepsi, 1926 *a*, p 53, Wenyon, 1926, pp 1183–6, Schoenichen, 1927, p 203, Sandon, 1927, p 181, Reichenow, 1929, p 1180, Kahl, 1930–5, p 328

Animalcules free-swimming, small to medium-sized, persistent in shape, generally ellipsoid or egg-shaped, posteriorly rounded, anteriorly somewhat less wide or even pointed Usually somewhat flattened dorso-ventrally Dorsal rows of cilia not strikingly bent to the right side anteriorly Some times with a thick covering of trichocysts Cytostome in the anterior half near the middle of the ventral surface, usually obliquely placed in a right anterior to left posterior direction, the right margin with a projecting ectoplasmic lip, inside are three ciliary structures—an outer membrane on the left, an inner beneath that, and a three-rowed ciliary band at the bottom on the right Cytopharynx more or less elongated, provided with an undulating membrane Contractile vacuole dorsal, median or subterminal Anal aperture subterminal Macronucleus central, round, with a micronucleus lying close to it Locomotion constant, moderately quick, often gliding on the ventral surface In soil, pond water or infusions Feeds on bacteria and fine detritus Can tolerate high concentration of carbon dioxide

Key to Indian Species

1 Body narrowed anteriorly Cytostome in the anterior fourth of the body, not obliquely placed Length 38–75 μ *G pyriformis* (Ehrbg), [p 170

2 Body broadly oval Cytostome in the anterior third of the body, usually obliquely placed Length 60–85 μ *G scintillans* Ehrbg, [p 172

91 **Glaucoma pyriformis** (Ehrenberg) Schewiakoff (Fig 75)

Leucophrys pyriformis, Ehrenberg, 1838, pp 312–13, pl xxxii, fig 4
Trichoda pyrum, Dujardin, 1841, pp 397–8
Glaucoma pyriformis, Schewiakoff, 1889, pp 35–6, pl iv, figs 54, 55, 1893, p 42, 1896, pp 298–9, pl iv, fig 104, Roux, 1901, p 55, pl iii, fig 6, Fauré Fremiet, 1911, p 207, Bullington, 1925, p 272, Lepsi, 1926 *a*, p 63, figs 173, 174, Wenyon, 1926, pp 1184–6, fig 502, Sandon, 1927, p 181, Schoenichen, 1927, p 203, fig 727, Knowles, 1928, fig 132
†*Glaucoma pyriformis*, Bhatia & Mullick, 1930, p 398
Glaucoma pyriformis, Kahl, 1930–5, p 330, fig 58, *13*

Animalcules free swimming, small to medium sized Body pear-shaped, narrowed but rounded anteriorly Cytostome in

the anterior fourth of the body, oval, elongated in the direction of the long axis of the body and not obliquely placed, surrounded along the left, anteriorly and on the right by a cap-like membrane Cytopharynx short, provided with a finger-shaped, protrusible undulating membrane Contractile vacuole single, near the posterior end Macronucleus rounded and central, with a small micronucleus

Dimensions —Length 32–75 μ, width 24–47 μ

Remarks —The specimens met with at Srinagar were somewhat smaller than the size usually given for the species, measuring only about 32 μ The cytostome in these specimens

Fig 75

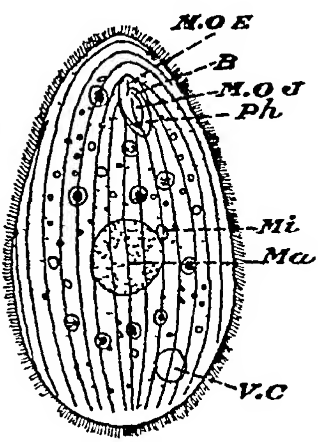


Fig 76

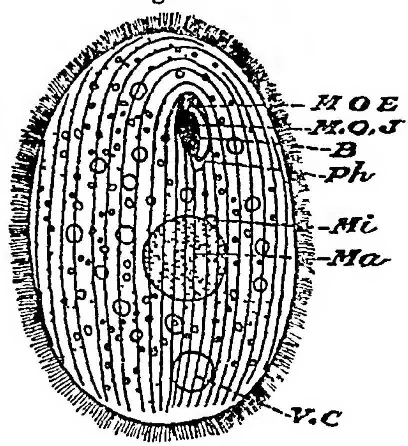


Fig 75 —*Glaucoma pyriformis* (Ehrbg) *B*, cytostome, *Ma*, macronucleus, *Mi*, micronucleus, *M O E*, external undulating membrane, *M O J*, internal undulating membrane, *Ph*, cytopharynx, *V C*, contractile vacuole (After Roux)

Fig 76 —*Glaucoma scintillans* Ehrbg Lettering as in the preceding figure (After Roux)

was oval and was provided with an undulating membrane attached along the left margin and extending along the anterior margin to its right border, the membrane along the right border was broader than that along the left Body cilia were fine and arranged in longitudinal rows The organism is narrower in front than *G scintillans*, and the undulating membrane is better developed on the right side of the cytostome

Habitat —Pond water KASHMIR, Srinagar

92 **Glaucoma scintillans Ehrenberg** (Fig 76)

Glaucoma scintillans, Ehrenberg, 1830, pp 53, 63, 70, 78, pl ix, fig 1, 1838, p 335, pl xxxvi, fig 5
Acomia ovulum, Dujardin, 1841, p 383, pl vii, fig 7
Acomia ovata, Dujardin, 1841, p 383, pl vi, fig 12
Glaucoma scintillans, Dujardin, 1841, pp 476–7, pl vi, fig 13, pl vii, fig 8, pl xiv, fig 4, Stein, 1854, pp 250–1, pl vi, figs 45–53, 1859 *d*, pp 74, 188, 1867, pp 92, 123, Schmarda, 1854, pp 7, 24, Samuelson, 1857, pp 18–19
Paramæcium ovale, Claparède & Lachmann, 1858–61, p 269, pl xiv fig 1
Glaucoma scintillans, Claparède & Lachmann, 1858–61, p 277, Pritchard, 1861, p 624, pl xxviii, figs 4–7, Balbiani, 1861, p 519, pl ix, figs 21, 22, Diesing, 1866, pp 76–7, Fromentel, 1874, pp 188, 306, pl xvi, fig 2, pl xxi, fig 24, Kent, 1880–2, pp 795–6, pl xlv, figs 39, 40, Maupas, 1883, pp 465–7, pl xix, figs 23, 24, 1888, pp 236–7, 1889, pp 261–3, pl xv, figs 66–72, Butschli, 1887–9, pp 1345, 1377, 1395, 1417, 1702, pl lxii, fig 5, *a–b*, Schewiakoff, 1889, pp 32–5, pl iv, figs 47–53, 1893, p 42, 1896, pp 297–8, pl iv, fig 103, Roux, 1901, p 54, pl iii, fig 5, Minchin, 1912, p 445, Prowazek, 1913, p 68
†*Glaucoma scintillans*, Gulati, 1925, p 748, fig 12
Glaucoma scintillans, Bullington, 1925, p 272, Calkins, 1926, p 383, fig 168, Lepsi, 1926 *a*, p 63, figs 171, 172, Kahl, 1926, pp 348–51, fig M_2, 1930–5 p 329, fig 58, *3*, Schoenichen, 1927, p 203, pl xii, fig 28, Sandon, 1927, p 181, pl vi, fig 8, Reichenow, 1929, p 1180

Animalcules free-swimming, small to medium-sized Body broadly oval, anteriorly only slightly narrowed Slightly flattened dorso ventrally, ventral surface flattened, dorsal convex Ciliary striations close, cilia short, fine and close-set Cytostome in the anterior third of the body, rather large, and somewhat obliquely placed Undulating membrane attached to the left, anterior, and right borders of the aperture, continuously moving Cytopharynx short, shallow and sac-like, with a large undulating membrane Contractile vacuole single, posterior Macronucleus spherical, with an adjacent micronucleus Very common in stagnant water Feeds on bacteria

Dimensions —Length 60–80μ, width 36–56μ

Remarks —Unlike other authors, Gulati shows the macronucleus as oval and granular in structure According to him the colour of the organism is greenish-white and a large number of food-vacuoles are scattered irregularly in the body

Habitat —Ditch water PUNJAB, Lahore

Genus COLPIDIUM Stein, 1860

Colpidium, Stein, 1860, p 47, Kent, 1880–2, p 537, Butschli, 1887–9, p 1704, Schewiakoff, 1896, p 303, Roux, 1901, p 56, Hickson, 1903, p 402, Penard, 1922, p 128, Lepsi, 1926*a*, p 53, Calkins, 1926, p 406, Wenyon, 1926, p 1175, Schoenichen, 1927, p 207, Sandon, 1927, p 181, Reichenow, 1929, p 1180, Kahl, 1930–5, p 333

Animalcules free-swimming, small to medium-sized Body oval to kidney-shaped, somewhat compressed, anterior end narrower and curved from left to right, posterior end rounded and broader The dorsal rows of cilia more or less sharply bent over to the right anteriorly Cytostome lateral, triangular, at some distance from the anterior end, situated in the right margin on the ventral surface, and leading into a moderately long, tubular cytopharynx, provided, as in *Glaucoma*, with a narrow undulating membrane along both margins, the right membrane continued into the cytopharynx and apparently attached to the dorsal wall Contractile vacuole in the middle of the dorsal border or terminal Anal aperture subterminal, ventral Macronucleus single or double, rounded or ellipsoid, central, with a micronucleus close by Fresh water and marine, very common in infusions and soils A facultative anærobe, developing abundantly where oxygen is deficient

Key to Indian Species

1 (2)	Contractile vacuole in the middle of the dorsal side A diagonal (adoral) depression on the anterior fourth of the body dorsally Length 30–150 μ	[Stein, p 174. *C colpoda* (Ehrb)
2 (1)	Contractile vacuole near the right border, in the posterior third or quarter of the body	3
3 (4)	Ellipsoidal, rounded at both ends Length 50–120 μ	[Bresslau, p 173 *C campylum* (Stokes)
4 (3)	Egg shaped, more pointed anteriorly Length 35–50 μ	[p 175 *C striatum* Stokes,

93 Colpidium campylum (Stokes) Bresslau (Fig 77)

Tillina campylum, Stokes, 1886 *a*, pp 103–4, pl i, fig 12, 1888, pp 44–5, pl iii, figs 42, 43
Glaucoma colpidium, Schewiakoff, 1893, p 48, 1896, pp 300–1, pl iv, fig 107
Colpidium campylum, Bresslau, 1922, pp 21–8
†*Colpidium compyla*, Gulati, 1925, p 748, fig 14
Colpodium campylum, Lepsi, 1926 *a*, p 62, fig 190, Kahl, 1930–5, p 334, fig 58, *17–19*

Form very variable according to locality and state of nutrition, long finger-shaped to short ovoid, rounded at the two ends Ciliary rows wider apart than in *C colpoda*.

Dorsal surface shows a more or less distinct bend but never an adoral depression Cytostome and cytopharynx as described for the genus Contractile vacuole near the right margin, in the posterior third or fourth of the body Macronucleus spherical, central Micronucleus close to the macronucleus or some distance behind Very common in stagnant water, infusions and soil

Dimensions —Length 50–120μ

Fig 78

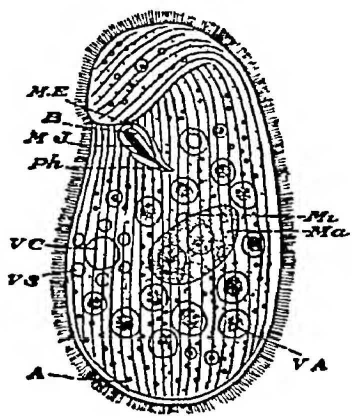


Fig 77

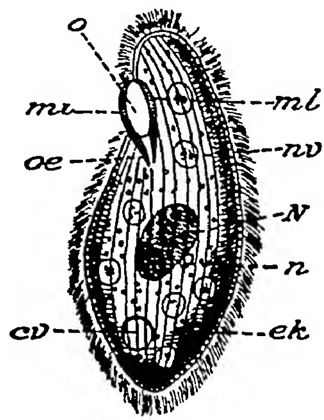


Fig 77 —*Colpidium campylum* (Stokes) *cv*, contractile vacuole, *ek*, ectoplasm, *mi*, right undulating membrane, *ml*, left undulating membrane, *N*, macronucleus, *n*, micronucleus, *nv*, food-vacuole, *o*, cytostome, *oe*, cytopharynx (After Schewiakoff)

Fig 78 —*Colpidium colpoda* (Ehrbg) *A*, anus, *B*, cytostome, *Ma*, macronucleus, *M E*, external undulating membrane, *Mi*, micronucleus, *M J*, internal undulating membrane, *Ph*, cytopharynx, *V C*, contractile vacuole, *V S*, subsidiary vacuoles (After Roux)

Remarks —This species is usually described as more elongated than the other members of the genus The specimens examined at Lahore by Gulati were four times as long as broad and measured 70μ by 17μ Contractile vacuole is shown by him as postero-terminal, and the micronucleus a little in front of it

Habitat —Hay infusion PUNJAB, Lahore

94 Colpidium colpoda (Ehrenberg) Stein (Fig 78)

Paramecium colpoda, Ehrenberg, 1831, p 114, 1833, pp 174, 324, pl iii, fig 3, 1837, p 164, 1838, p 352, pl xxxix, fig 9
Kolpoda cucullus, Dujardin, 1841, pp 479–81, pl iv, fig 29
Paramæcium colpoda, Claparède & Lachmann, 1858–61, p 267
Colpidium colpoda Stein, 1860, p 47, 1867, pp 69, 118, 158 160
Colpidium ren, Stein, 1867, p 41

Colpidium cucullus, Kent, 1880–2, pp 537–8, pl xxvii, fig 49
Colpidium colpoda, Maupas, 1883, pp 459–60, pl xix, figs 30, 31, 1888 *a*, pp 235–6, 1889, pp 238–49, pls xiv–xv, figs 1–38
Glaucoma pyriformis Gourret & Roeser, 1886, pp 513–14, pl xxxiv, fig 6
Colpidium colpoda, Butschli, 1876, pp 313–15, pl ix, figs 7–11, pl x, figs 26–8, 1887–9, p 1704, pl lxii, fig 6, Schewiakoff, 1889, pp 42–4, pl v, figs 65–8, 1893, p 46, 1896, pp 305–6, pl iv, fig 110, pl vii, fig 200, Roux, 1901, p 57, pl iii, fig 10
†*Colpidium colpoda*, Bhatia, 1920, p 261
Colpidium colpoda, Penard, 1922, p 128, fig 130
†*Colpidium colpoda*, Gulati, 1925, p 749, pl ii, fig 15
Colpidium colpoda, Lepsi, 1926 *a*, pp 61–2, figs 188, 189, Schoenichen, 1927, p 207, pl xii, fig 31, Sandon, 1927, p 182, pl vi, fig 4, Kahl, 1930–5, p 334, fig 58, *21*, *22*

Body ovoid anteriorly bent towards the right side Dorsal surface convex, covered with closely situated, longitudinal ciliary lines bent over to the right anteriorly, ventral surface presenting a depression or concavity in its anterior part Torsion mentioned by many authors is merely an appearance, due to the dorsal rows of cilia on the anterior part being prolonged on to the ventral surface, whereby the preoral seam is strongly curved to the left Posterior extremity bears some longer cilia in addition to the normal ones Cytostome and undulating membranes as described for the genus Contractile vacuole single, situated in the middle of the dorsal surface Macronucleus round or ellipsoid, with a single micronucleus Very common in infusions and soils

Dimensions—Length 100–150μ (Sandon gives 30–45μ, Roux, length 90–120μ, width 50–80μ)

Remarks—In the forms met with at Lahore the cytostome was situated at the bottom of a triangular depression and was not followed by a cytopharynx, both margins of the oral fossa bore simple, flap-like undulating membranes Contractile vacuole was postero-terminal Macronucleus was large, rounded, subcentral

Habitat—Infusion of leaves PUNJAB, Lahore

95 **Colpidium striatum** Stokes (Fig 79)

Colpidium striatum, Stokes, 1886 *a*, pp 103–4, pl i, fig 12, 1888, p 177, pl iv, fig 28
†*Colpidium striatum*, Gulati, 1925, p 748, fig 13
Colpidium striatum, Sandon, 1927, p 182
†*Colpidium striatum*, Madhava Rao, 1928, p 114, pl iii, fig 5
Colpidium striatum, Kahl, 1930–5, p 334, fig 60, *10*

Body egg-shaped, anterior end narrower than the posterior Cytostome and cytopharynx as described for the genus Contractile vacuole single, near the posterior end Macronucleus spherical, central, micronucleus small, situated a little in front of the macronucleus

Dorsal surface shows a more or less distinct bend but never an adoral depression Cytostome and cytopharynx as described for the genus Contractile vacuole near the right margin, in the posterior third or fourth of the body Macronucleus spherical, central Micronucleus close to the macronucleus or some distance behind Very common in stagnant water, infusions and soil

Dimensions —Length 50–120μ

Fig 78

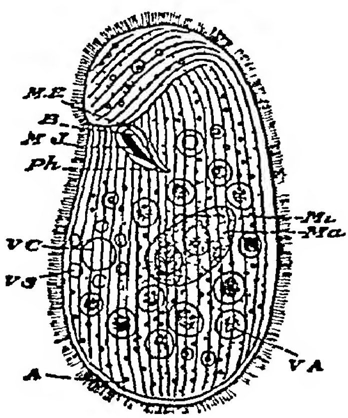


Fig 77

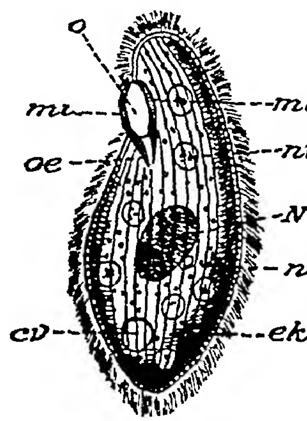


Fig 77 —*Colpidium campylum* (Stokes) *cv*, contractile vacuole, *ek*, ectoplasm, *mi*, right undulating membrane, *ml*, left undulating membrane, *N*, macronucleus, *n*, micronucleus, *nv*, food vacuole, *o*, cytostome, *oe*, cytopharynx (After Schewiakoff)

Fig 78 —*Colpidium colpoda* (Ehrbg) *A*, anus, *B*, cytostome, *Ma*, macronucleus, *M E*, external undulating membrane, *Mi*, micronucleus, *M J*, internal undulating membrane, *Ph*, cytopharynx, *V C*, contractile vacuole, *V S*, subsidiary vacuoles (After Roux)

Remarks —This species is usually described as more elongated than the other members of the genus The specimens examined at Lahore by Gulati were four times as long as broad and measured 70μ by 17μ Contractile vacuole is shown by him as postero-terminal, and the micronucleus a little in front of it

Habitat —Hay infusion PUNJAB, Lahore

94 **Colpidium colpoda** (Ehrenberg) Stein (Fig 78)

Paramecium colpoda, Ehrenberg, 1831, p 114, 1833, pp 174, 324, pl iii, fig 3, 1837, p 164, 1838, p 352, pl xxxix, fig 9
Kolpoda cucullus, Dujardin, 1841, pp 479–81, pl iv, fig 29
Paramæcium colpoda, Claparède & Lachmann, 1858–61, p 267
Colpidium colpoda Stein, 1860, p 47, 1867, pp 69, 118, 158 160
Colpidium ren, Stein, 1867, p 41

Contractile vacuole single, situated near the middle Macronucleus ovoidal, situated about the middle, with a micronucleus close behind it

Dimensions —Length 60 μ

Remarks —This form, met with in a pond at Lahore in August, 1918, and which I referred with some hesitation to *Glaucoma pyriformis*, probably belongs to the genus *Pseudoglaucoma* recently described by Kahl This genus differs from *Glaucoma* in possessing a single strong membrane arising from the left border and projecting into a concave ectoplasmic lip-like structure The cytostome is situated in the right border, as in *Colpidium*, and not about the middle of the ventral surface, as in *Glaucoma*

Fig 80

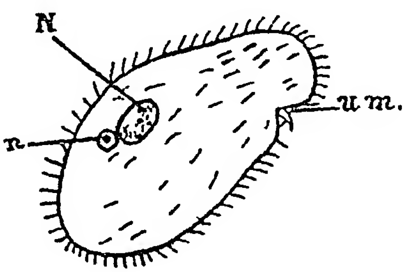


Fig 81

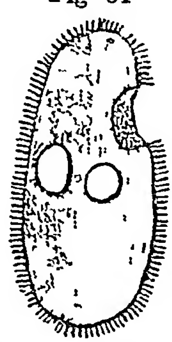


Fig 80 —*Pseudoglaucoma digitata*, sp nov *N*, macronucleus, *n*, micronucleus, *u m*, undulating membrane

Fig 81 —*Stegochilum ovale* Ghosh (After Ghosh)

The animals measure 60 μ in length and 30 μ in width The form of the body is somewhat pyriform and the ciliation uniform, though very fine Cilia along the margin are equally fine and rather widely separate from one another The cytostome is situated along the right border, at 9 μ from the anterior end, and the triangular oral fossa is provided with a single membrane stretching across it and with a finger-shaped projection protruding from its middle

It differs from the other species of *Pseudoglaucoma* recently described by Kahl in its larger size, the position of the contractile vacuole, and form of the macronucleus

Habitat —Pond water PUNJAB, Lahore

Genus STEGOCHILUM Schewiakoff, 1893

Stegochilum, Schewiakoff, 1893, p 48, 1896, p 282, Kahl, 1930–5, p 337

Distinguishable from *Glaucoma* by the absence of the oral funnel and the inner membrane The outer membrane is inserted continuously along the left, anterior and right margins, and covers the cytostome anteriorly in a cap like manner

98 **Stegochilum ovale** Ghosh (Fig 81)

†*Stegochilum ovale*, Ghosh, 1921 *a*, p 9, fig 7
Stegochilum ovale, Kahl, 1930–5, p 337

Body elongately oval, wider posteriorly, and rounded at both ends Cytostome in the anterior half of the body Undulating membrane attached to the left, anterior and right margin of the cytostome No cytopharynx Longitudinal ciliary striæ meridional Contractile vacuole single, central Macronucleus oval, central Micronucleus at the side of the macronucleus Size not stated

Remarks—The species differs from the other two in the genus in its shape and the position of the macronucleus and the contractile vacuole

Habitat—Vegetable infusions BENGAL, Calcutta

Genus URONEMA Dujardin, 1841

Uronema, Dujardin, 1841, p 392, Kent, 1880–2, p 546
Cryptochilum, Maupas, 1883, p 443, Schewiakoff, 1896, p 284
Uronema, Butschli, 1887–9, p 1705, Schewiakoff, 1896, p 280, Roux, 1901, p 52, Hickson, 1903, p 402, Penard, 1922, pp 111–117, Calkins, 1926, p 405, Wenyon, 1926, pp 1180–3, Lepsi, 1926 *a*, p 51, Schoenichen, 1927, p 208, Knowles, 1928, p. 522, Kahl, 1930–5, p 355

Body egg-shaped or elongated, not strongly flattened Ventral surface with a depression in the neighbourhood of the cytostome Body covered with fine cilia, longitudinal striations strongly marked Anteriorly an unciliated frontal pole From the anterior end a faint groove runs back to the cytostome, the right margin of the groove being provided with stronger cilia Posterior end of the body provided with a long caudal seta Oral aperture oval in the direction of the long axis of the animal, with an undulating membrane along its left margin and a row of special cilia along the right Cytopharynx absent Contractile vacuole single, posterior Macronucleus spherical, central, with a micronucleus adjacent to it Locomotion swift, with rotation on its long axis Feeds on bacteria, algæ and detritus

99 **Uronema accuminatum** Madhava Rao (Fig 82)

†*Uronema accuminata*, Madhava Rao, 1928, p 115, pl iii, fig 1

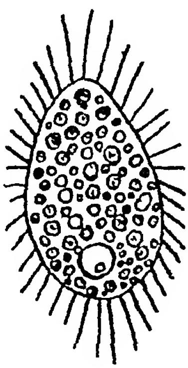
Allied to *U marinum*

Dimensions —Length 50μ

Remarks —Madhava Rao has recorded this species without mentioning the name of the author of the species He gives

Fig 83

Fig 82



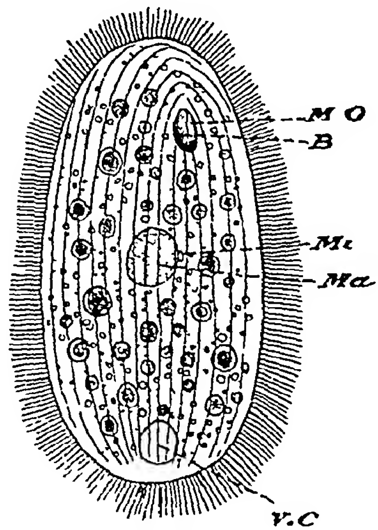


Fig 82 —*Uronema accuminatum* Madhava Rao (After Madhava Rao)
Fig 83 —*Uronema marinum* Duj *B*, cytostome, *Ma*, macronucleus, *Mi*, micronucleus, *M O*, undulating membrane, *V C*, contractile vacuole (After Roux)

no description, and from the figure given it is impossible to ascertain if the organism belongs to *Uronema* at all

Habitat —Soil Mysore

100 **Uronema marinum** Dujardin (Fig 83)

Uronema marinum, Dujardin, 1841, p 392, pl vii, fig 13
Uronema marina, Cohn, 1866, pp 275–6, pl xv, fig 53
Uronema marinum, Kent, 1880–2, p 546, pl xxvii, figs 60 & 61
Cryptochilum nigricans, Maupas, 1883
Uronema marina, Maupas, 1883, p 618, Butschli, 1887–9 pp 1704–5, pl lxiv, fig 1, Schewiakoff, 1889, pp 44–5, pl v figs 69–71, 1893, p 47, 1896, pp 281–2, pl iv, fig 92, Roux 1901, p 52, pl iii, fig 2, Lepsi, 1926 *a*, p 59, figs 195, 196,

Wenyon, 1926, p 1182, fig 500 B, Schoenichen, 1927, p 209, pl xii, fig 34
Loxocephalus putrinus, Kahl 1926
†*Uronema marina*, Madhava Rao, 1928, p 114, pl iii, fig 2
Uronema marinum, Kahl, 1930–5, p 356, fig 60, *21, 22, 24*

Very small to small Body elongated, ellipsoidal in shape, with slight lateral compression Cilia arranged uniformly in longitudinal rows, a single long bristle at the posterior end Cytostome a longitudinal oval opening on the ventral surface in the anterior part of the body, with a row of closely-set cilia on the right border and an undulating membrane on the left No cytopharynx Contractile vacuole single, posterior Macronucleus spherical, central, micronucleus adjacent Movements rapid, rotating on the long axis

Dimensions —Length 30–60 μ

Remarks —Madhava Rao records *U marina* without naming the author of the species From his brief description it is inferred that *U marinum* Duj is intended He mentions that the ventral side is almost straight from the mouth to the front and drawn out, the dorsal side being curved Cilia are described as short and thick, though fine and close set cilia are characteristic of the species, and his figure shows fairly long cilia

Habitat —Soil Mysore

2 Family OPHRYOGLENIDÆ Kent, 1882, emend Kahl, 1931

Body ciliated on all sides, with a peristome The peristome runs as a sickle-shaped ciliated cleft, perpendicular to the surface of the body, into the depressed oral aperture An hourglass shaped body lies in front of the anterior end of the peristomial cleft

The family includes the single genus *Ophryoglena*

Genus **OPHRYOGLENA** Ehrenberg, 1831

Ophryoglena, Ehrenberg, 1831, p 117, 1838, p 360
Otostoma Carter, 1856 *a*, pl ix, figs 6–8, 1856 *b*, p 119
Ophryoglena, Claparède & Lachmann, 1858–61, p 256
Panophrys, Stein, 1860 *a*, p 61
Otostoma, Kent, 1880–2, p 500
Ophryoglena, Butschli, 1887–9, p 1703, Schewiakoff, 1896, p 317, Roux, 1901, p 60, Hickson 1903, p 402, Penard, 1922, pp 145–152, Calkins, 1926, p 406, Schoenichen, 1927, p 205, Reichenow, 1929, p 1180, Kahl, 1930–5, p 360

Body oval, often dorso-ventrally flattened Cilia fine, close and uniform, in longitudinal rows meeting in front of

the cytostome Sometimes exhibiting a buccal area with special cilia Cytostome on the anterior part of the ventral surface, an elongated oval slit, semilunar, with concavity towards the left, its right border provided with special cilia, which follow a spiral direction Cytopharynx with narrow undulating membrane To the left of the cytostome is an organ of unknown function, of a semilunar form, called the "hour-glass organ" A pigment spot sometimes present in the anterior part of the body Contractile vacuoles varying in number and position Macronucleus of variable form Locomotion swift, uninterrupted by rotation on the long axis Feeds on detritus or fat-globules

101 **Ophryoglena flava** (Ehrenberg) (Fig 84)

Bursaria flava, Ehrenberg, 1833, p 233, 1838, p 330, pl xxxv, fig 2
Panophrys flava, Dujardin, 1841, p 494
†*Otostoma* sp, Carter, 1856 *a*, pl ix, figs 6–8, 1856 *b*, p 119
Panophrys flava, Stein, 1860 *a*, p 61
Ophryoglena flava, Claparède & Lachmann, 1858–61, pp 257–8
Bursaria flava, Stein, 1867, pp 44, 67, 92
†*Otostoma carteri*, Kent, 1880–2, p 500, pl xxvi, figs 55–8
Panophrys flava, Kent, 1880–2, p 534
Ophryoglena flava, Butschli, 1887–9, pp 1703–4, pl lxi, fig *11*, pl lxii, fig 2, Schewiakoff, 1893, p 46, Roux, 1901, p 61, pl iii, fig 16, Penard, 1922, pp 145–8, fig 143, Calkins, 1926, p 383, fig 168, Lepsi, 1926 *a*, p 56, fig 184, Schoenichen, 1927, p 206, Reichenow, 1929, pp 166, 1180, fig 200, Kahl, 1930–5, p 361, fig 61, *39*

Very large Body elongated oval, rounded at both extremities Cytostome well developed, situated in a depression on the ventral surface at about one-third of the length of the body from the anterior end Cytopharynx ear-shaped, longitudinally plicate, recurved and narrower at its posterior extremity Anal aperture postero-terminal Cilia of cuticular surface short, even, and disposed in fine, parallel, longitudinal lines Contractile vacuoles two, one in the anterior and the other in the posterior part of the body, with long, narrow radiating canals Macronucleus elongated, elliptical or fusiform, placed obliquely about the middle

Dimensions —Length 250–400μ Penard gives 500μ, Roux 560μ

Remarks —Carter gave a brief description of this form from Bombay, and Kent subsequently named it *Otostoma carteri* Later authorities have considered it to be identical with *Ophryoglena flava* (Ehrbg) *O flava* is usually described as narrower and pointed posteriorly, but Carter's form is described and figured as narrower anteriorly Carter made the interesting observation that the organism encysts within the internodes

of semi-decayed *Nitella*, and segments into two, four, or eight individuals, which are subsequently liberated from the cyst

Habitat—Fresh water, among *Nitella* BOMBAY, Bombay

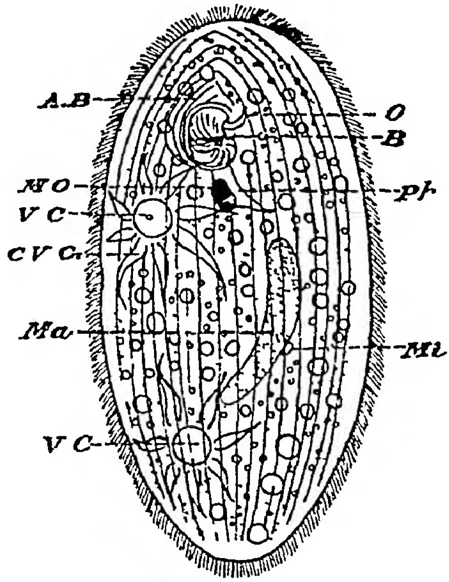


Fig 84 —*Ophryoglena flava* (Ehrbg) *A B*, buccal area, *B*, cytostome, *C V C*, radiating canal, *Ma*, macronucleus, *Mi*, micro nucleus, *M O*, undulating membrane, *O*, hour glass organ, *Ph*, cytopharynx, *V C*, contractile vacuoles (After Roux)

3. Family PLEURONEMATIDÆ Kent, 1882

Body with long cilia, longer or more powerful in the anterior region Peristome extends along the surface of the body from the anterior pole to the oral aperture Peristomial plate bears along the right border an undulating membrane, which surrounds the hinder margin of the oral aperture like a pocket Left peristomial border bears a ciliary row or membrane

Key to Indian Genera

1 (2) Peristomial groove small, at the anterior end	BALANTIOPHORUS, [p 186.
2 (1) Peristomial groove reaching at least up to the middle of the body	3
3 (4) Large size, 70–188 μ, peristome beginning near the anterior end and with a semicircular excavation on the left near the cytostome	PLEURONEMA, p 184
4 (3) Small size, rarely a little more than 50 μ, without a semicircular excavation of the peristome near the cytostome	CYCLIDIUM, p 183

Genus CYCLIDIUM Hill, O F Muller, 1773

Cyclidium, Hill, 1752, O F Muller, 1773, pp xxvii & 49
Cyclidium, part, Ehrenberg, 1838, p 245
Cyclidium, Claparède & Lachmann, 1858–61, p 271, Stein, 1867, p 159, Fromentel, 1874, p 189, Kent, 1880–2, p 544, Bütschli, 1887–9, p 1713, Schewiakoff, 1896, p 357, Roux, 1901, p 73, Hickson, 1903, pp 401, 403, Calkins, 1926, pp 385, 407, fig 169, Lepsi, 1926 *a*, p 48, Wenyon, 1926, p 1183 Schoenichen, 1927, p 216, Reichenow, 1929, p 1180, Kahl, 1930–5, p 375

Small to very small, ovoid, with one or more long caudal setæ at the posterior extremity An unciliated, distinctly truncated frontal plate is always present anteriorly Peristomial groove generally extending to two-thirds of the length of the body, wider posteriorly Right peristomial margin with membrane which encloses the small oral groove like a pocket, the entrance to which is provided with preoral cilia The left margin of the peristome bears either free cilia or a membrane, which becomes continuous behind with the membrane arising from the right side Contractile vacuole single, posterior Macronucleus spherical with an adjacent micronucleus

102 Cyclidium glaucoma O F Muller (Fig 85)

Cyclidium glaucoma, O F Müller, 1786, p 80, pl xi, figs 6–8, Ehrenberg, 1829, pp 10, 11, 15, 19, 20, 1838, pp 245–6, pl xxii, fig 1
Alyscum saltans, Dujardin, 1841, p 391, pl vi, fig 3
Enchelys nodulosa, Dujardin, 1841, p 389, pl vi, fig 2, pl vii, fig 9
Acomia cyclidium, Dujardin 1841, p 382, pl vii, fig 5
Cyclidium glaucoma, Claparède & Lachmann, 1858–61, pp 272–3
Pleuronema cyclidium, Claparède & Lachmann, 1858–61, p 276, pl xiv, fig 6
Cyclidium glaucoma, Stein, 1860 *a*, p 59, 1867, p 159
Cyclidium nigricans, Fromentel, 1874, p 307, pl iii, fig 10
Cyclidium glaucoma, Kent, 1880–2, pp 544–5, pl xxvii, figs 57, 58, Gourret & Roesser, 1886, pp 479–80, pl xxix, figs 11, 12, pl xxx, fig 1, Bütschli, 1887–9, pp 1713–14, pl lxiv, fig 8, Stokes, 1888, p 183, Maupas, 1889, pp 271–2, pl xvi, fig 14, Schewiakoff, 1889, pp 60–2, pl vii, figs 94–6, 1893, p 54, 1896, pp 359–61, pl v, fig 133, Roux, 1901, p 74, pl iv, fig 11
†*Cyclidium glaucoma*, Bhatia, 1922, p 30
Cyclidium glaucoma, Penard, 1922, pp 180–1, fig 180
†*Cyclidium glaucoma*, Gulati, 1925, p 750, fig 19
Cyclidium glaucoma, Lepsi, 1926 *a*, p 54, fig 241, Wenyon, 1926, p 1182, fig 500 A, Schoenichen, 1927, p 216, pl xii, fig 46, Sandon, 1927, p 186, Thomson & Robertson, 1929, p 278, fig 187, *2*
†*Cyclidium glaucoma*, Chaudhuri, 1929, p 54
Cyclidium glaucoma, Kahl, 1930–5, p 376, fig 64, *26*

Very small Body ovate, compressed, a little over twice as long as broad, cuticular surface longitudinally striate.

Cilia of the general surface of the body long and fine, with a single very long and conspicuous caudal seta Contractile vacuole postero-terminal Macronucleus spheroidal, central, with an adjacent micronucleus Locomotion jerky In pond water and infusions

Dimensions —Length 18–24 μ, width 10–12 μ

Remarks —Specimens found at Lahore measured on an average 18 μ in length The peristome did not extend much behind the middle of the body and the undulating membrane was large, hood-like and extensile

Habitat —Pond water PUNJAB, Lahore, soil BENGAL, Sibpore

Fig 85

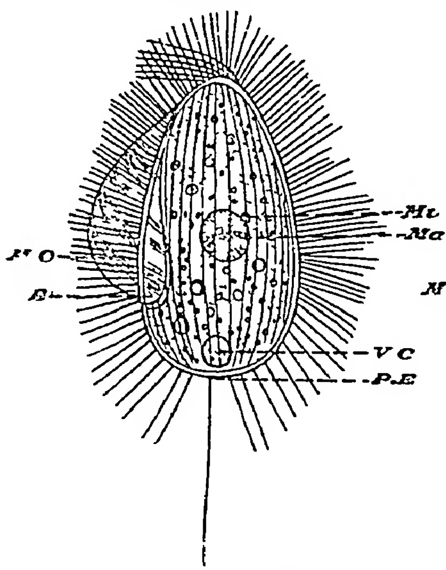


Fig 86

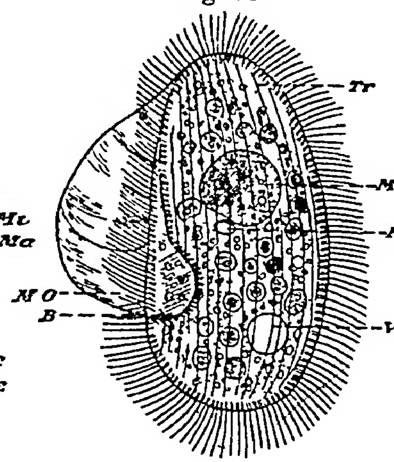


Fig. 85 —*Cyclidium glaucoma* O F Müll *B*, cytostome, *Ma*, macronucleus, *Mi*, micronucleus, *M O*, undulating membrane, *P E*, excretory pore, *V C*, contractile vacuole (After Roux)

Fig 86 —*Pleuronema chrysalis* (O F Müll) *Tr*, trichocysts, other lettering as in fig 85 (After Roux)

Genus PLEURONEMA Dujardin, 1841

Pleuronema, Dujardin, 1841, p 474, Claparède & Lachmann, 1858–61, p 274, Stein, 1867, p 159, Fromentel, 1874, p 186, Kent, 1880–2, p 542, Butschli, 1887–9, p 1713, Schewiakoff, 1896, p 354, Roux, 1901, p 71, Hickson, 1903, pp 401, 403, Minchin, 1912, pp 439, 442, Lepsi, 1926 *a*, p 48, Wenyon, 1926, p 1183, Schoenichen, 1927, p 214, Sandon, 1927, p 186, Reichenow, 1929, p 1180, Kahl, 1930–5, p 387

Body persistently egg-shaped, only slightly flattened laterally, anterior end somewhat narrower than the posterior

Body covered uniformly with long, fine bristle-like cilia, arranged in longitudinal lines which converge below the peristome Peristome occupying nearly the whole of the ventral surface, beginning near the anterior extremity and widening behind, extending along three-fourths of the entire length of the body, and posteriorly strongly excavated along the left side Cytostome small, at the posterior extremity of the peristome near the left border Cytopharynx absent From the left border of the peristome arises a large and broad undulating membrane which, passing along the posterior side of the fossa, extends along the right side of the peristome Contractile vacuole single, posterior, dorsal Macronucleus large, spherical, situated in the anterior part of the body, with a single micronucleus Movements irregular, during the course of which the membrane can be drawn into the peristome, rotation on its long axis, suddenly stopping for longer or shorter intervals, in the course of which the membrane is extended Feeding on organic debris and bacteria In pond water Not common in soils

Pleuronema is recognizable from the other genera of the family chiefly by its larger size and by the possession of a semicircular excavation of the peristome in the neighbourhood of the cytostome

103 **Pleuronema chrysalis** (O F Muller) (Fig 86)

Paramœcium chrysalis, O F Müller, 1786, p 90, pl xii, figs 15–20
Paramecium chrysalis, Ehrenberg, 1829, pp 7, 10, 17, 20, 1830, pp 25, 43, 54, 56, 65, 78, pl iv, fig 2, 1831, p 114, 1835, p 164, 1838, p 352, pl xxxix, fig 8
Pleuronema crassa, Dujardin, 1841, pp 474–5, pl vi, fig 1, pl xiv, fig 2
Pleuronema marina, Dujardin, 1841, p 475, pl xiv, fig 3
Pleuronema chrysalis, Perty, 1852, p 146, Claparède & Lachmann, 1858–61, pp 274–6, pl xiv, fig 8, Stein, 1859 *d*, pp 61, 62, 73, 77, 1860 *a*, p 58, 1867, p 159, Fromentel, 1874, p 401, pl xxi, fig 10, pl xxii, fig 16, Kent, 1880–2, p 543, pl xxvii, fig 55
Pleuronema coronata, Kent, 1880–2, p 544, pl xxvii, fig 56
Pleuronema chrysalis, Bütschli, 1887–9, p 1713, pl lxiv, fig 6, Schewiakoff, 1889, pp 58–60, pl vii, figs 92, 93, 1893, pp 53–4, 1896, pp 356–7, pl v, fig 132, Roux, 1901, p 71, pl iv, fig 9, Hickson, 1903, fig 52, Minchin, 1912, p 56, fig 27
†*Pleuronema chrysalis*, Ghosh, 1921 *a*, p 10
Pleuronema chrysalis, Lepsi, 1926 *a*, p 54, fig 236, Calkins, 1926, p 385, fig 169 Sandon, 1927, p 186, Schoenichen, 1927, p 215, pl xii, fig 44, Reichenow, 1929, pp 178, 1180, fig 207, Kahl, 1930–5, pp 387–8, fig 65, *23*

Small to medium-sized Body irregularly egg-shaped, more or less flattened laterally, right margin straight, left convex, anteriorly narrowed, rounded at both extremities Long and fine cilia in even longitudinal rows over the whole cuticular surface, cilia at the posterior end not specially

elongated Left border of the peristome deeply excavated posteriorly Undulating membrane narrow anteriorly and rapidly widening posteriorly, equal in width to the body when fully extended Contractile vacuole single, postero-dorsal Macronucleus large, spherical, anterior to the middle, with an adjacent micronucleus Mostly remains quiet, when disturbed shows swift, straight locomotion

Dimensions —Length 70–120 μ

Remarks —Kent considers this species identical with *Paramecium chrysalis* Ehrenberg Kahl remarks that *Paramecium chrysalis* O F Muller is undoubtedly a true *Paramecium*, and so is Ehrenberg's form of that name described in 1831 Ehrenberg later removed it to *Pleuronema* If *Paramecium chrysalis* of O F Muller and Ehrenburg are not to be placed in the genus *Pleuronema* the correct name of the above species would be *Pleuronema crassa* Dujardin

The contractile vacuole is stated by Kent to be situated anteriorly He also states that the oral fossa is followed by a tubular pharyngeal passage In both these characters descriptions given by other authors differ from Kent Sandon, in his description of the genus, says " undulating membrane sometimes withdrawn into pharynx while animal is not feeding, mouth at posterior end of peristome without pharynx " He probably means that the membrane is withdrawn into the peristome, as there is no pharynx

Habitat —Hay infusions BENGAL, Calcutta

104 **Pleuronema** sp

†*Pleuronema* sp , Sandon, 1927, p 186

Habitat —Doubtfully recorded from culture from a soil from BURMA, Hmawbi

105 **Pleuronema** sp

†*Pleuronema* sp , Chaudhuri, 1929, p 54

Habitat —In soil The locality is not indicated in Table III of Chaudhuri's paper

Genus **BALANTIOPHORUS** Schewiakoff, 1889

Balantiophorus, Schewiakoff, 1889, p 64 , 1893, p 56 , 1896, p 365 , Roux, 1901, p. 75 , Lepsi, 1926 *a*, p 52 , Schoenichen, 1927, p 214 , Sandon, 1927, p 187
Glaucoma, part, Kahl, 1930–5, p 332
Espejoia, part, Kahl, 1930–5, p 337
Cyrtolophosis, Kahl, 1930–5, p 353

Body transparent, elongated egg-shaped, rounded at both ends, dorsal side more convex than the ventral Cilia

fine, often longer at the anterior end Peristome short, confined to the anterior portion of the ventral surface Left, posterior and right margins of the peristome with a bag-like undulating membrane, which can be withdrawn into the peristome Contractile vacuole posterior Macronucleus ovoid, central Locomotion very lively, with rotation Feeds on bacteria

Remarks —Kahl thinks that the genus *Balantiophorus* was wrongly established by Schewiakoff for certain species which had already been described and placed in the genus *Cyrtolophosis* Stokes, 1888 As Stokes' work is not available to me and the generic name *Cyrtolophosis* is not noted in the 'Zoological Record,' I am retaining *Balantiophorus* as a generic name

Key to Indian Species

1 Body elongate and rather narrow Cilia sparsely scattered [p 187 *B elongatus* Schew ,

2 Body shorter and broader Cilia arranged in longitudinal rows [p 187 *B minutus* Schew ,

106 **Balantiophorus elongatus** Schewiakoff (Fig 87)

Balantiophorus elongatus, Schewiakoff, 1893, pp 56–7, pl iv, fig 50, 1896, p 368, pl vi, fig 139 , Lepsi, 1926 *a*, p 61, fig 256
†*Balantiophorus elongatus*, Sandon, 1927, p 187, pl vi, fig 7 , Chaudhuri, 1929, p 60 pl ii, figs 32–3
Cyrtolophosis elongata, Kahl, 1930–5, p 354, fig 61, *5*

Very small Shape elongate and rather narrow Cilia long, sparsely scattered and not arranged in longitudinal rows Peristome short, occupying only the anterior part of the ventral surface Contractile vacuole single, posterior Macronucleus oval, central, with a small micronucleus A common soil Ciliate

Dimensions —Length 28–30μ, width 10μ

Habitat —Soils from KASHMIR, Srinagar , N W F PROVINCE, Peshawar , PUNJAB, Gurdaspur, Jullundhur, Lahore, Ghora Gali , UNITED PROVINCES, Agra, Benares , BOMBAY, Dharwar CENTRAL INDIA, Indore , MADRAS, Kanara , BENGAL, Cuttack, Sibpore, Calcutta, Chittagong , BIHAR, Patna , ASSAM, Cinnamara (near Jorhat) , CEYLON, Colombo

107 **Balantiophorus minutus** Schewiakoff (Fig 88)

Balantiophorus minutus, Schewiakoff, 1889, pp 64–5, pl vii, figs 99–101 , 1893, p 56 , 1896, pp 367–8, pl vi, fig 138 , Roux, 1901, p 75, pl iv, fig 14 , Lepsi, 1926 *a*, p 61, fig 255 , Schoenichen, 1927, p 214, fig 737
†*Balantiophorus minutus*, Sandon, 1927, p 188 , Chaudhuri, 1929, p 60, pl ii, figs 17–19
Cyrtolophosis mucicola, Kahl, 1930–5, p 354, fig 61, *2*

Very small Body ovoid, very narrow in front, broadly

rounded posteriorly Cilia short, uniform, arranged in distinct longitudinal rows Contractile vacuole postero-lateral Macronucleus spherical, central, with a small micronucleus

Dimensions —Length 24–28μ, width 9–12μ

Remarks —*B minutus* is shorter and broader than *B elongatus*, and is further distinguished by the cilia being more numerous and arranged in distinct longitudinal rows

Fig 87

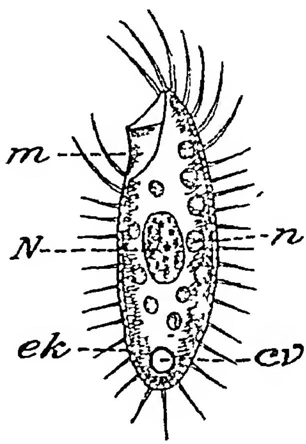


Fig 88

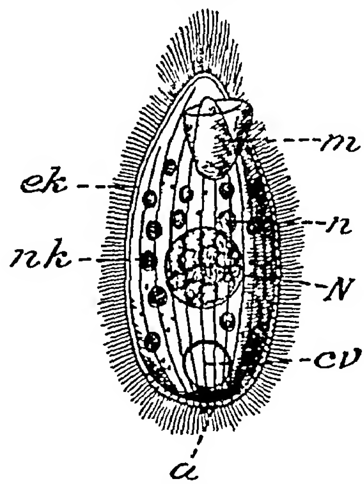


Fig 87 —*Balantiophorus elongatus* Schew *cv*, contractile vacuole, *ek*, ectoplasm, *m*, cytostome, *N*, macronucleus, *n*, micro nucleus (After Schewiakoff)

Fig 88 —*Balantiophorus minutus* Schew *a*, anus, *cv*, contractile vacuole, *ek*, ectoplasm, *m*, cytostome, *N*, macronucleus, *n*, micronucleus, *nk*, food vacuole (After Schewiakoff)

Habitat —Soils from N W F Province, Peshawar, Punjab, Lahore, Jullundhur, United Provinces, Dehra Dun, Bombay, Dharwar, Madras, Coimbatore, Bihar, Patna, Bengal, Sibpore, Calcutta, Chittagong

108 **Balantiophorus** sp

†*Balantiophorus* sp, Chaudhuri, 1929, p 54

Habitat —Soils from Punjab Lahore, Ceylon, Colombo

4. Family UROCENTRIDÆ Claparède & Lachmann, 1858.

Body cylindrical or barrel-shaped, with cilia confined to two or three ciliary girdles, with or without a tuft of caudal cilia Cytostome obliquely placed about the middle Cytopharynx with undulating membranes and free cilia Contractile vacuole single, terminal Macronucleus horseshoe-shaped

Key to Indian Genera

1 With three ciliary girdles and a caudal tuft	UROCENTRUM, p 189
2 With two ciliary girdles, and without a caudal tuft	TELOTRICHIDIUM, [p 191

Genus UROCENTRUM Nitzsch, 1817

Urocentrum, Nitzsch, 1817, p 4, 1827, p 68, Ehrenberg, 1838, p 268, Dujardin, 1841, p 531, Claparède & Lachmann, 1858–61, p 134, Stein, 1867, p 161, Kent, 1880–2, p 641, Butschli, 1887–9, p 1711, Schewiakoff, 1896, p 344, Roux, 1901, p 69, Hickson, 1903, p 403, Calkins, 1926, p 405, Lepsi, 1926 *a*, p 49, Schoenichen, 1927, p 212, Reichenow, 1929, p 105, Kahl, 1930–5, p 354

Flexible Body almost cylindrical, barrel-shaped, rounded anteriorly and posteriorly With three ciliary girdles, the anterior and posterior broad, and a narrow one of shorter cilia in the middle, posteriorly a ciliary tuft, and a ciliary row along the right margin Peristomial furrow narrow, narrowing from the posterior end to the middle of the body, where the cytostome is situated Cytostome obliquely placed Cytopharynx with a row of longer cilia along its dorsal wall Contractile vacuole terminal, with four or eight elongated canals Macronucleus horseshoe-shaped Anus posterior Locomotion swift, with rotation on its long axis and frequent changes of direction

109 **Urocentrum turbo** (O F Muller) (Fig 89)

Cercaria turbo, O F Muller, 1786, pp 123–4, pl xviii, figs 13–16
Urocentrum turbo, Nitzsch, 1817, p 4, 1827, p 68, Ehrenberg, 1830, p 66, 1838, p 268, pl xxiv, fig 7, Dujardin, 1841, pp 531–2, Claparède & Lachmann, 1858–61, pp 134–5, Stein, 1859 *d*, p 73, 1867, pp 69, 118, 148 Pritchard, 1861 p 584, pl x, figs 231, 232
†*Urocentrum turbo*, Carter, 1865, pp 399–402

Urocentrum turbo, Fromentel, 1874, pp 259–60, pl xxiv, figs 5, 5 *a*, Kent, 1880–2, pp 641–3, pl xxxiii, figs 7–10, Entz, 1882, pp 179–89, pl viii, figs 12–14, Bütschli, 1887–9, pp 1711–12, pl lxiv, fig 15, Schewiakoff, 1889, pp 49–54, pl vi, figs 76–86, 1893, p 53, 1896, pp 347–8, pl v, fig 130, pl vi, fig 165, pl vii, figs 166–8, 186, 190, 205, Roux, 1901, p 70, pl iv, fig 7
†*Urocentrum turbo*, Gulati, 1925, p 749, pl ii, fig 17
Urocentrum turbo, Bullington, 1925, pp 224, 269, Lepsi, 1926 *a*, p 56, fig 234, Calkins, 1926, p 383, fig 168 D, Schoenichen, 1927, p 213, pl xii, fig 42
†*Urocentrum turbo*, Bhatia & Mullick, 1930, pp 398–9
Urocentrum turbo, Kahl, 1930–5, pp 354–5, fig 61, *26* & *26 a*

Body flexible and unevenly cylindrical, rounded at both ends Three ciliary girdles the anterior very wide, the

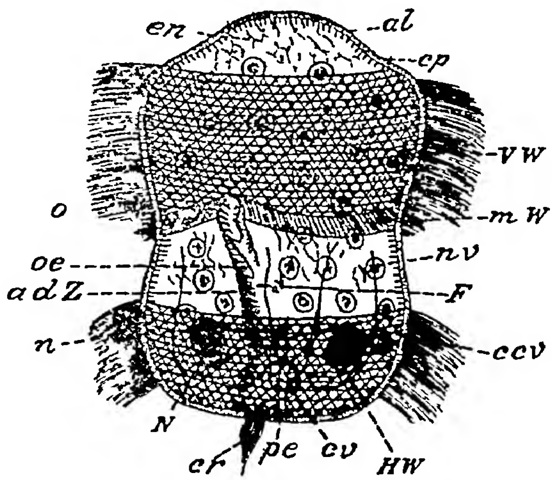


Fig 89 —*Urocentrum turbo* (O F Müll) *adZ*, adoral zone, *al*, alveolar layer, *ccv*, radial canal, *cp*, pellicle, *cr*, caudal ciliary tuft, *cv*, contractile vacuole, *en*, endoplasm, *F*, furrow, *HW*, posterior ciliary girdle, *mW*, middle ciliary girdle, *N*, macronucleus, *n*, micronucleus, *nv*, food vacuole, *o*, cytostome, *oe*, cytopharynx, *pe*, excretory pore, *Vw*, anterior ciliary girdle (After Schewiakoff)

posterior less so, and the one round the middle narrow and consisting of very short cilia Cytostome obliquely placed just behind the middle ciliary girdle, a narrow furrow extends backwards from it to the hinder end of the body Contractile vacuole single posterior Macronucleus horseshoe-shaped, with two spherical extremities, placed horizontally across the posterior region of the body, with a single micro nucleus lying about its middle

Dimensions —Usually 50–80μ, rarely 80–110μ, in length

Remarks —The organisms were found at Srinagar in pond water overgrown with *Lemna* They became very abundant

in a jar containing pond water richly covered with *Lemna* during the course of two or three days, but a little later they became very scarce again. Specimens were unusually small, varying from 33μ to 60μ. The body appeared to be divided into two regions by a constriction in the middle. The posterior region was narrower and provided with a long, flattened and flexible caudal appendage, formed of a bundle of cilia; in some specimens this appendage was either not present or was seen to be curved up over the body. The anterior part of the body was vacuolated. Trichocysts were very abundant and distributed all over the body.

Kahl describes in the cytopharynx a stiff ectoplasmic membrane which divides the funnel into an anterior portion (with two undulating membranes) and a posterior portion (with basal ciliary field). The contractile vacuole is usually described as possessing four radiating canals, but according to Kahl there are eight, reaching the middle of the body.

Habitat.—Pond water: KASHMIR, Srinagar; PUNJAB, Lahore. Fresh water: Bombay.

Genus **TELOTRICHIDIUM** Kent, 1880–2

Telotrichidium Kent, 1880–2, p. 643; Butschli, 1887–9, p. 1764; Lepsi, 1926 *a*, p. 18; Kahl, 1930–5, p. 663.

Free-swimming, ovate or campanulate, possessing no caudal appendage. Ciliary girdles two in number. Oral aperture ventral, immediately behind the anterior wreath of cilia. Anal aperture postero-terminal. Contractile vacuole and macronucleus conspicuously developed. Multiplying by longitudinal fission.

110. **Telotrichidium matthaii** Gulati. (Fig. 90.)

*Telotrichidium natthaii**, Gulati, 1925, p. 749, pl. ii, fig. 18.
Telotrichidium nathaei, Kahl, 1930–5, p. 663.

Animalcules entirely free-swimming, ovate, campanulate or subquadrate, with a convex anterior margin and a retractile, knob-like projection protruded asymmetrically on one side of the posterior margin. Cilia restricted to two girdles, each consisting of a single row; posterior girdle hidden from view on retraction. Cytostome in the middle of the body on the ventral side, followed by a ciliated cytopharynx. Anus situated close to the posterior projection. Contractile vacuoles one or two, lying in the neighbourhood of the mouth. Macronucleus horseshoe-shaped. Micronucleus oval or rounded,

* *natthaii* is an obvious misprint for *matthaii*.

near one of the angles of the macronucleus Fission always longitudinal

Dimensions —Length 145 μ, width 108 μ

Remarks —Gulati has recorded longitudinal fission and also encystment in this species He has also described conjugation between individuals of unequal size As pointed out by him, the individuals show some resemblance to Vorticellæ detached from their stalks

This species differs from the only other previously known species of the genus, *Telotrichidium crateriforme,* in that (1) the posterior girdle of cilia runs obliquely almost along the

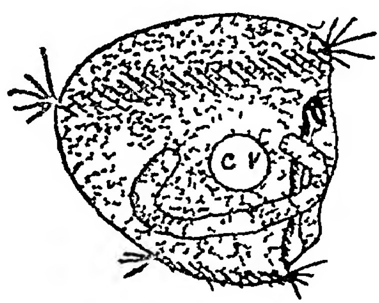


Fig 90 —*Telotrichidium matthaii* Gulati c v, contractile vacuole (After Gulati)

posterior border, (2) there is no thick anterior annular border, and (3) the posterior end is retractile

Gulati's observations seem to show that *Telotrichidium* is a valid genus, whose position is close to *Urocentrum* The true Vorticellæ may be supposed to have been derived from such Hototrichan forms as *Urocentrum* and *Telotrichidium*, and these forms were actually placed in the order PERITRICHA by Kent, but later workers have shown that their correct position is among the HYMENOSTOMATA Kahl is, however, of the opinion that the so-called species of *Telotrichidium* are Vorticellæ detached from their stalks

Habitat —Ditch water in which dry leaves were rotting PUNJAB, Lahore

4 Suborder *THIGMOTRICHA* Chatton & Lwoff

HOLOTRICHA in which the anterior body cilia form a group for attaching the organism to the substratum (thigmotactic apparatus) They include forms at very different levels of organization, including on the one hand forms which possess a highly organized cytostomial apparatus, and on the other forms in which a cytostome is almost or quite absent, and which consequently absorb their food by means of a sucking tentacle With the exception of a few species, they all live in the mantle-cavities of various marine or freshwater molluscs, where they may be attached by the thigmotactic field of cilia, or may show free locomotion

Identification Table of Families

1 (4)	Ciliation uniform, in closely situated meridional rows, body laterally flattened peristome not beginning close to the anterior end of the body	2
2 (3)	Thigmotactic field extending over the whole of one surface, peristome and cytostome well developed commensals or parasites of molluscs or sea-urchins . .	[p 194 **Conchophthiridæ** Kahl,
3 (2)	Thigmotactic field reduced to a small part of the left surface, oral funnel without distinct peristome, contractile vacuole opening into the cytostome ...	[Chatton & Lwoff **Thigmophryidæ** *
4 (1)	Ciliation not uniform ..	5
5 (10)	Ciliary rows distributed irregularly on both surfaces or in a spiral course, or largely or even completely rudimentary, cytostome with well-developed peristome, or cytostome rudimentary or absent . .	**Ancistrumidæ** * Issel
6 (9)	Chiefly entozoic in mussels, less often in snails and holothurians	7
7 (8)	Laterally flattened, ciliary rows meridional, adoral zone begins near the anterior end and winding to the left, extends to the cytostomial groove situated near the posterior end	[MINÆ * Kah Subfam ANCISTRU-
8 (7)	Ciliary rows meridional or markedly spiral, adoral zone spiral, beginning	

from the anterior end and extending to the posterior end — [Pickard † Subfam BOVERIINÆ*

9 (6) Epizoic on echinoderms Ciliation complete Cytostome rudimentary or absent — [RINÆ* Konig Subfam HEMISPEI

10 (5) Ciliation greatly reduced, with a short sucking tentacle for attachment, cytostome functionless or completely absent, multiplication by ciliated buds — 11

11 (12) Adult forms showing two rows of basal granules in furrows, but the cilia themselves only rarely visible Multiplication by buds which carry both the basal groups which develop into cilia Nutrition by osmosis Completely fixed to the branchial lamellæ of mussels — [Chatton & Lwoff **Sphenophryidæ***

12 (11) Cilia reduced to a thigmotactic field at the anterior end, adoral cilia present in addition to an attaching tentacle, or adoral cilia absent and only an attaching and food absorbing tentacle present Fixed to the gills of mussels or to the stalk of Vorticellids or Suctoria — **Hypocomidæ*** Butschli

Family CONCHOPHTHIRIDÆ Kahl, 1931

Body laterally flattened, uniformly ciliated, creeping on the somewhat concave left surface The right surface shows a peristomial groove extending from the ventral border to the middle of the body, at the bottom of this lies the oral funnel Cytopharynx ciliated Contractile vacuole single, central Macronucleus simple or multipartite Commensals or parasites of molluscs and sea-urchins

Genus **CONCHOPHTHIRIUS** Stein, 1861

Conchophthirius, Stein, 1861, p 87, 1867, pp 64, 336, Engelmann, 1862, p 379
Conchophthirus, Kent, 1880–2, p 490, Butschli, 1887–9, p 1720, Calkins, 1926, p 407, Strand, 1928, p 31, Reichenow, 1929, p 1177, Kahl, 1930–5, pp 285–6

Body laterally flattened, ventral border extended, somewhat concave in the neighbourhood of the cytostome, dorsal border curved Left side flat or somewhat dish-shaped, right surface broad, slightly convex A depression on the ventral side as in *Colpoda* Cytostome at the bottom of the

† Pickard (1927) has separated the genus *Boveria* from the family Ancistrumidæ and placed it in a new family Boveridæ under HETEROTRICHA, but this view is not accepted by Reichenow (1929), Cheissen (1931), Calkins (1933), and Kahl (1934 *a*)

depression, followed by a funnel bent dorsally and provided with cilia Cilia on the body fine, thickly set, usually presenting a tufted or matted aspect Contractile vacuole single, usually near the middle of the body Macronucleus simple or multipartite Commensals on various Lamellibranchiate and Gastropod Mollusca

Remarks —Raabe (1932) has used Klein's method to demonstrate the silver-line system in four species of this genus The silver-line system provides a well-defined characteristic of the genus and indicates clear differences between the species Kidder (1934) describes a well-integrated neuromotor system It consists of an external fibrillar system, demonstrated by Klein's silver-nitrate method, and an internal set of fibres, demonstrated after hæmatoxylin destained with 10 per cent hydrogen peroxide

Key to Indian Species

1 (3)	Peristomial groove opens ventralwards between the middle and posterior end of the ventral border	2
2	Body 1½ times as long as broad No cytopharynx Contractile vacuole sub central Macronucleus posterior, oval	*C lamellidens* Ghosh, [p 197
3 (1)	Peristomial groove opens ventralwards at or in front of the middle of the ventral border	4
4	Left side without depression	5
5 (6)	Form very broad Ciliated cytopharynx very long, extending across almost close to the dorsal border Contractile vacuole near the macronucleus Macronucleus oval, subcentral	*C curtus* Engelmann, [p 195
6 (5)	Form narrow, elongated, with parallel sides, 2½ times as long as broad Contractile vacuole single, about ⅓ length of the body from the posterior end Macronucleus oval, posterior	*C elongatus* Ghosh, [p 196

111 **Conchophthirius curtus** Engelmann (Fig 92)

Conchophthirius curtus, Engelmann, 1862, pp 379–81, pl xxxi, fig 2, Kent, 1880–2, p 491
†*Conchophthirus curtes*, Ghosh, 1918, p 133, fig 2
Conchophthirus curtus, Kahl, 1930–5, p 287, fig 47, *31*

Body shortly oval, nearly as broad as long, equally rounded at both extremities, dorsal border strongly convex, ventral flattened Peristomial depression somewhat in front of the middle of the ventral border Cytopharynx long, tubular, and recurved Cuticular surface delicately striate longitudinally, clothed throughout with long, fine, matted cilia, with a tuft of strong cilia at the posterior end of the right side

Contractile vacuole somewhat behind the middle, with subsidiary vacuoles surrounding it Macronucleus oval, subcentral, with one or two micronuclei

Dimensions —Length about 120μ

Remarks —Ghosh mentions that his specimens differed from the description of the species as given by Engelmann in the following points —The oval macronucleus is mostly placed with its long axis in a line with the length of the body, the contractile vacuole is without accessory vesicles, and the cytopharynx is not only directed dorsalwards, but also curves posteriorly at a little distance behind the macronucleus

Fig 91 Fig 92 Fig 93

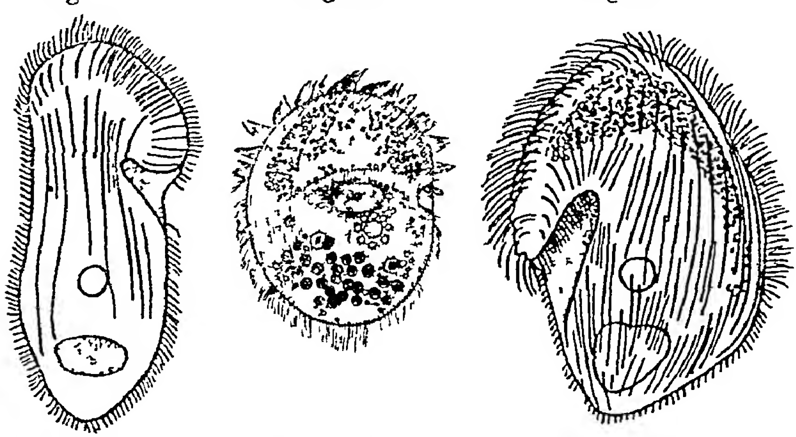


Fig 91 —*Conchophthirius elongatus* Ghosh (After Ghosh)
Fig 92 —*Conchophthirius curtus* Engelm (After Engelmann)
Fig 93 —*Conchophthirius lamellidens* Ghosh (After Ghosh)

There is obviously an error in his labelling fig 2 as *C elongatus* and fig 4 as *C curtus* Those consulting his original paper should note that what is given as fig 2 is really a figure of *C curtus*, and fig 4 of *C elongatus*

Habitat —In the mantle-chamber of *Lamellidens marginalis* BENGAL, Calcutta

112 Conchophthirius elongatus Ghosh (Fig 91)

†*Conchophthirus elongatus*, Ghosh, 1918, p 132, fig 4
Conchophthirus elongatus, Kahl, 1930–5, p 288, fig 47, *33*

Body elongated, about 2½ times as long as broad, wide anteriorly, anterior end rounded, posterior end narrow and bluntly pointed Dorsal border nearly straight, slightly convex in front and behind and faintly concave in the middle, ventral border with a shallow notch just behind the anterior third of the length of the body Peristome small, conical, directed

forwards and dorsalwards No cytopharynx Longitudinal ciliary striæ very marked at the anterior end, less so over the rest of the body Contractile vacuole single, at the junction of the middle and posterior third of the body-length, sometimes slightly displaced Macronucleus oval, posterior and subterminal

Dimensions —Length 50 μ

Habitat —In the mantle-chamber of *Lamellidens marginalis* BENGAL, Calcutta

113. **Conchophthirius lamellidens** Ghosh (Fig 93)

†*Conchophthirus lamellidens*, Ghosh, 1918, p 132, fig 3
Conchopthirus lamellidens, Kahl, 1930–5, p 286, fig 47, *35*
†*Conchopthirus lamellidens*, Ray & Chakravarty, 1934 *a*, p 1, 1934 *b*, pp 663–4

Body ovate, about $1\frac{1}{2}$ times as long as broad, bluntly pointed at both ends, dorsal border strongly convex, ventral convex and minutely dentate in the anterior and slightly notched in the posterior half Peristome in the anterior portion of the notch, short and tubular, being directed forwards and dorsalwards Generally a dark granular zone in the endoplasm in the anterior third of the body Longitudinal striæ very distinct Contractile vacuole single, subcentral Macronucleus oval or triangular, posterior and subterminal

Dimensions —Length 90 μ

Remarks —Ray and Chakravarty (1934 *a*) have studied the morphology of this Ciliate in detail, but their observations have not yet been published They (1934 *b*) also claim to have discovered a lunar periodicity in conjugations in this Ciliate

Habitat —In the mantle-chamber of *Lamellidens marginalis* BENGAL, Calcutta

5 Suborder *APOSTOMEA* Chatton & Lwoff

Endoparasitic HOLOTRICHA in which the cytostome is reduced to a small rosette or quite absent In the family Fœttingeridæ, which includes a number of genera and species, the organisms show a complicated life-history accompanied by change of hosts At encystment the helicoidal ciliation of the vegetative individuals or "trophonts" disappears, the cilia being detached from the body and remaining in the mucous wall of the cyst Later in the encysted stage the ciliary bands show a meridional instead of a helicoidal course The encysted individual known as the "tomont" undergoes a transverse fission which is described as linear palintomic multiplication, resulting in the formation of a number of free-swimming parts called "tomites" The tomites acquire a ciliation differing from the trophont, and later metamorphose into trophonts within a phoretic cyst They are parasites of Crustacea and Cœlenterata In the family Opalinopsidæ are included endoparasites of the kidneys and liver of Heteropoda and Cephalopoda

Identification Table of Families

1 (2) Asymmetrical forms with the cytostome reduced to a small rosette With few meridional rows of cilia and reduced adoral row Macronucleus often branching or like a network Micronucleus and contractile vacuole near the cytostome Complicated life history — **Fœttingeridæ*** [Chatton

a Tomite and trophont with cytostomial rosette, tomont in the cyst with meridional rows, with short postoral rows in two groups — Subfam FŒTTINGERIINÆ* Chatton & [Lwoff

b Tomite and trophont without cytostomial rosette, tomont freely motile, with incompletely distorted ciliary rows — Subfam POLYSPIRINÆ* [Chatton & Lwoff

c Only known as trophont in the gastrovascular cavity of a ctenophore — Subfam PERICARYONINÆ* Chatton & [Lwoff

2 (1) Oval or elongated forms, with cilia in the form of helicoid bands, cytostome present or absent Macronucleus breaks up into chromidia Multiplication by buds which remain united to form chains Parasites in the kidney or liver of Cephalopoda and Heteropoda — **Opalinopsidæ*** Hartog

6 Suborder *ASTOMATA* Schewiakoff, emend Cépède.

The ASTOMATA are parasites of various Invertebrate hosts and are chiefly found in the Annelids They generally live in the alimentary canal, though some forms are found in the body-cavity and in the tissues of various organs

Cépède (1910, 1923) recognized as many as eleven families, only two of which, viz Anoplophryidæ and Haptophryidæ, comprise a large number of forms, the others being based on a single species in each case The family Anoplophryidæ was further subdivided into six subfamilies Rossolimo (1926) described a new genus *Radiophrya* and placed it in a seventh subfamily of Anoplophryidæ Cheissen (1930) gave a new classification, and divided ASTOMATA into six families, viz, Anoplophryidæ, Intoshellinidæ, Maupasellidæ, Hoplitophryidæ, Haptophryidæ, and Chromidinidæ The family Anoplophryidæ was divided into eight and Hoplitophryidæ into three subfamilies As in Cépède's classification, the family Anoplophryidæ was treated as a lumber-room, and several of the subfamilies, based on a single species, were referred to it More recently Heidenreich (1935 *a*) has further revised this classification and divided the group into only three families, viz, Anoplophryidæ, Hoplitophryidæ and Intoshellinidæ He revised the synonymy of many species, and excluded from this scheme a large number of insufficiently characterized species

Identification Table of Families

1 (2)	Skeletal elements completely absent Body elongated Cilia in long and close rows Macronucleus elongated	Anoplophryidæ Cepède, [p 200
2 (1)	Skeletal elements present	3
3 (4)	With an organ of fixation, in the form of a girdle with spikes or a disc with teeth, at the anterior end of the body Cilia long, arranged spirally or in longitudinal rows	**Intoshellinidæ*** Cépède
4 (3)	With an organ of fixation, consisting of a pointed spike, or with a supporting skeleton, lying in the ectoplasm, or partly in the ectoplasm and partly in the endoplasm	**Hoplitophryidæ** Cheis-[sin, p 205

1 Family ANOPLOPHRYIDÆ Cépède, 1910, emend. Cheissen, 1930; further emend Heidenreich, 1935.

Body elongated Skeleton completely absent Cilia arranged in long and close rows Contractile vacuoles variable in number and position Macronucleus elongated The family is divided into two subfamilies, as follows —

1 Without an anterior unciliated cone, rounded at both ends, anterior end often broader than the posterior	[Cépède, p 200 ANOPLOPHRYINÆ
2 With an anterior unciliated cone peculiar arrangement of ciliary rows	[Cépède BUTSCHLIELLINÆ*

Subfamily ANOPLOPHRYINÆ Cépède, 1910

Body elongate, cylindrical or slightly flattened, rounded at both ends, anterior end often broader than the posterior It is uniformly ciliated, there being no anterior unciliated cone Reproduction by transverse division, which may lead to the separation of chains of buds from the posterior end of the body Includes a single genus

Genus **ANOPLOPHRYA** Stein, 1860

Anoplophrya Stein, 1860 *a*, p 57, Kent, 1880–2, p 563, Butschli, 1887–9, p 1716, Schewiakoff, 1896, p 379, Cépède, 1910, p 411, Rossolimo, 1926 *a*, pp 471–3, Wenyon, 1926, p 1167, Reichenow, 1929, p 1183, Cheissen, 1930, pp 545–7, 608–9, Kudo, 1931, p 341, Kahl, 1934 *a*, p 175, Heidenreich 1935 *a*, pp 319–26, 362–3, 387–8

Endoparasites Free-swimming, mouthless, body cylindrical or flattened, rounded at both extremities, thickly and uniformly ciliate, possessing no supplementary organs of prehension Contractile vacuole or vacuoles well developed Macronucleus mostly band-like and axial Occurring as parasites within the intestinal viscera of various Invertebrata

Key to Indian Species

1 (4) Contractile vacuole single	2
2 (3) Posterior end with a notch Macronucleus club shaped, pointed anteriorly.	*A variabilis* Ghosh, [p 204
3 (2) Posterior end pointed Macronucleus band shaped, straight or curved	*A ælosomatis* Anderson, p 201
4 (1) Contractile vacuoles multiple	5

5 (8)	Contractile vacuoles scattered irregularly	6
6 (7)	Contractile vacuoles three Body oval, subtruncate posteriorly Macronucleus ribbon shaped	*A lloydi* Ghosh, [p 202
7 (6)	Contractile vacuoles four Body cylindrical, wider anteriorly Macronucleus ribbon-shaped	*A cylindrica* Ghosh, [p 202
8 (5)	Numerous vacuoles arranged in two rows, mostly non contractile	9
9	Body elongate, band like, anterior end dilated, posterior tapering Macronucleus band-like	*A elongata* Ghosh, [p 203

114 **Anoplophrya ælosomatis** Anderson (Fig 94)

†*Anoplophrya ælosomatis* Anderson, 1889, pp 381–3, pl i, figs 1–5
Anoplophrya maupasi, Cépède, 1910, pp 411–18, pl xiii, figs 47–65 text-fig 3
Radiophrya (?) *ælosomatis*, Heidenreich, 1935 *a*, pp 366–7

Body oval, tapering at both ends, tapering portion considerably produced posteriorly, twice as long as broad Surface

Fig 94

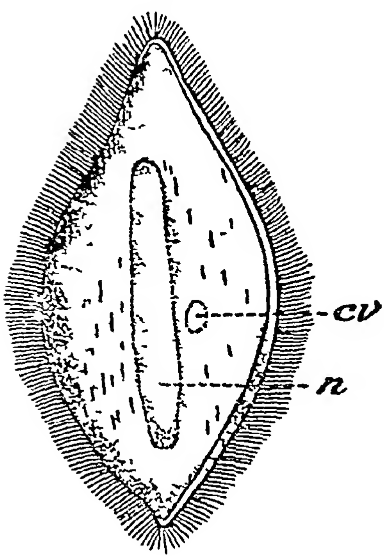


Fig 95

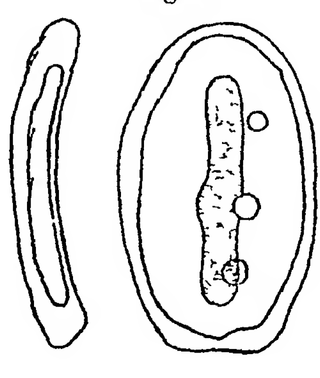


Fig 94 —*Anoplophrya ælosomatis* Anderson *cv*, contractile vacuole, *n*, macronucleus (After Anderson)
Fig 95 —*Anoplophrya lloydi* Ghosh Cilia not shown in the figure (After Ghosh)

densely ciliated and finely striated in a longitudinal direction Contractile vacuole single, central, close to the macronucleus Macronucleus axial, band-shaped, extending nearly the

whole length of the body, generally straight, sometimes curved or S-shaped, coarsely granular

Multiplication by transverse fission in numerous cases a second constriction and appearance of fission anterior to the first, the segments remaining attached for some time and the posterior segment breaking off first These compound forms are considerably larger, measuring up to 227 μ in length

Dimensions —Length 62–83 μ

Remarks —Heidenreich (1935) regards *A maupasi* Cépède as a synonym of this species, and considers it as doubtfully belonging to the genus *Radiophrya* Rossolimo But as the latter genus is characterized by the possession of radial striations arranged in a fan-like manner and a pointed organ of fixation, and there is no hint of either of these in the original descriptions or figures by Anderson or Cepède, I am letting the species stand in the genus *Anoplophrya*

Habitat —In the alimentary canal of the Oligochæte *Ælosoma chlorosticum* Wood-Mason BENGAL, Calcutta

115 **Anoplophrya lloydi** Ghosh (Fig. 95)

†*Anoplophrya lloydii*, Ghosh, 1918, p 129, fig 1, 1921, p 6
Anoplophrya lumbrici, Heidenreich, 1935 *a* pp 319–323

Elongately oval, with subtruncate posterior end, curved longitudinally, the dorsal side convex and ventral concave Ciliary striæ close Contractile vacuoles three, on the right side Macronucleus irregularly ribbon-shaped, extending nearly the whole length of the body, micronucleus small, spherical, placed by the side of the macronucleus Size not stated

Remarks —The species is stated by Ghosh to be nearest to *A striata* Duj in many respects Heidenreich (1935 *a*), however, considers *A lloydi* as a synonym of *A lumbrici* (Schrank) He has revived that name, and refers quite a number of species of different authors to it I am, however, letting Ghosh's species stand till the organisms have been studied again by someone

Habitat —In seminal vesicles of the earthworm, *Pheretima posthuma* (L Vaill) BENGAL, Calcutta

DOUBTFUL SPECIES

116 **Anoplophrya cylindrica** Ghosh (Fig 96)

†*Anoplophrya cylindrica*, Ghosh, 1922 *c*, p 284, fig 1

Body elongated and cylindrical, about six times as long as its transverse diameter, anterior one third of the body is stouter than the rest Both extremities rounded, the anterior

a little wider than the posterior Ectoplasm thin, endoplasm finely granular Contractile vacuoles four and irregularly arranged Macronucleus elongated, extending through almost the entire length of the body

Dimensions —Length about 230 μ

Remarks —This form resembles *A paranoides* Pierantoni, and differs from other species of the genus in having an elongated and cylindrical body. It differs from *A paranoides*

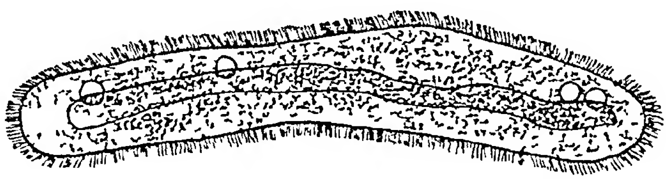


Fig 96 —*Anoplophrya cylindrica* Ghosh (After Ghosh)

in having a rounded posterior end, short cilia, a macronucleus without a club-shaped anterior end, in the number of contractile vacuoles, and in its occurrence in a host belonging to an entirely different phylum

Habitat —In the intestinal canal of *Vivipara bengalensis* (the common banded pond-snail) BENGAL, Calcutta

117 **Anoplophrya elongata** Ghosh (Fig 97)

†*Anoplophrya elongata*, Ghosh, 1921 *a* p 6, fig 1

Body elongated and band-like, sometimes twisted in the posterior region Anterior end slightly dilated and rounded Lateral margins nearly parallel to each other Posterior end tapering bluntly to a point Cilia small and uniformly arranged in faint longitudinal rows Numerous small vacuoles arranged in two longitudinal rows, mostly non-contractile Macronucleus flattened and band-like, extending through almost the entire length of the body

Dimensions —Length 150 μ, width 30 μ

Remarks —Heidenreich (1935 *a*) considers both *A elongata* and *A variabilis* as lying outside the family Anoplophryidæ as they are not sufficiently characterized, and I think the same remark can apply to *A cylindrica* I am, however, including the description of these species, as these were published in journals not easily obtainable, and the forms are well worth fresh study

Habitat —In the rectum of small freshwater Gastropods BENGAL, Calcutta

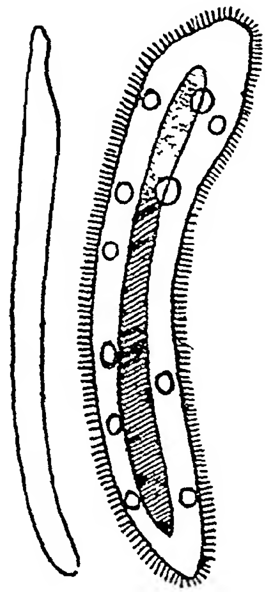


Fig 97 —*Anoplophrya elongata* Ghosh (After Ghosh)

118 **Anoplophrya variabilis** Ghosh (Fig 98)

†*Anoplophrya variabilis*, Ghosh, 1921 *a*, pp 6–7, fig 2

Body band-like, about three to four times as long as broad, with parallel sides Anterior end rounded, posterior end with

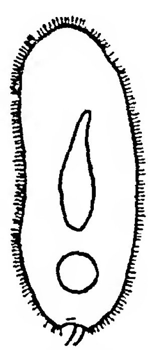


Fig 98 —*Anoplophrya variabilis* Ghosh (After Ghosh)

a minute notch Body uniformly covered with small cilia arranged in faint longitudinal rows Two curved hook-like cirri sometimes supplemented by long cilia at the notched

posterior end Contractile vacuole single, posterior Macronucleus club-shaped, with the pointed end anterior

Dimensions —Length 84–174 μ

Habitat —In the intestinal tract of small freshwater Gastropods BENGAL, Calcutta

2 Family HOPLITOPHRYIDÆ Chiessen, 1930, emend Heidenreich, 1935.

Forms possessing a skeleton, which forms an organ of fixation, consisting of a pointed spike (sometimes denticulated) or a supporting skeleton lying in the ectoplasm, or partly in the ectoplasm and partly in the endoplasm

Heidenreich (1935 *a*) has combined the families Hoplitophryidæ Cheissen and Maupasellidæ (Cépede) Cheissin into one, and divides it into five subfamilies, viz , Eumonodontophryinæ*, Hoplitophryinæ*, Radiophryinæ*, Mesnilellinæ*, and Maupasellinæ, of which the last one only is known from India so far

Subfamily MAUPASELLINÆ Cepède, 1910

Body elongated Skeleton at the anterior end, consisting of a free, mobile spike, with an ectoplasmic basis and endoplasmic skeletal rods connected with it

Genus **MAUPASELLA** Cépède, 1910

Maupasella, Cépède, 1910, p 408 , Calkins, 1926, p 402 , Wenyon, 1926, p 1168 , Reichenow, 1929, p 1183 , Kudo, 1931, p 341

Endoparasites, with an anterior fixation apparatus in the form of a conical process derived from thickened ectoplasm Body with dense ciliation Contractile vacuoles irregularly disposed Macronucleus elongated and ribbon-shaped Micronucleus spindle-shaped, with its axis parallel to that of the body

119 Maupasella nova Cépède (Fig. 99)

Maupasella nova, Cepède, 1910, pp 408–10, figs 29–33 and text fig 2, Keilin, 1920, pp 92–4, pl vi, figs 1–18, Wenyon, 1926, p 1168, fig 493, 2, 2 a
†*Maupasella nova,* Bhatia & Gulati, 1927, pp 100–2
Maupasella nova, Reichenow, 1929, p 1183, Kudo, 1931, p 341, fig 146 *f*, Heidenreich, 1935, pp 345–8 figs 7, 8

Possesses the characters of the genus

Dimensions —Varies much in size and form, long specimens measuring 80–130 μ by 18–25 μ, and short ones only 50–77 μ by 25–47 μ

Remarks —The general form of the parasite, as stated by Cépède, is variable, but two very distinct types can be distinguished, viz, ovoidal and elongated The measurements of an ovoidal form are length of the body 77 μ, width of

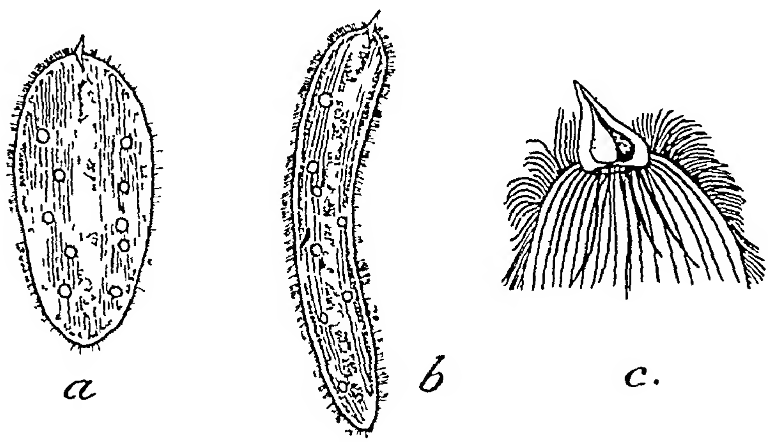


Fig 99 —*Maupasella nova* Cépède a, oval form, b, elongated form, c, an enlarged view of the fixation apparatus (a & b, after Cépède, c, after Heidenreich)

the body anteriorly 25 μ, posteriorly 22 μ, length of the nucleus 65 μ Such individuals are the outcome of transverse division of the elongated form They are dorso-ventrally flattened, broader anteriorly and gradually taper towards the narrower posterior end, which is bluntly rounded like the anterior end The anteriorly placed fixation apparatus is mobile The whole body is very flexible, and the individuals are sometimes seen to bend themselves into a semicircle

The measurements of an elongated individual are length of the body 130 μ, width of the body 18 μ, length of the nucleus 90 μ These are forms that are about to divide transversely The individuals often show a constriction about the middle, indicating that fission will shortly take place Others, which

do not show such a constriction, are highly flexible and are often curved into a coil The individuals are of nearly uniform width throughout and look like a piece of flat ribbon rounded at both ends The cilia are fine and close-set, and form a dense covering over the body, they are disposed in longitudinal rows The fixation apparatus is triradiate in form The radius projecting out of the body anteriorly is shorter than the other two, but all are sharply pointed and slightly curved There are many contractile vacuoles, disposed irregularly in some individuals and arranged in two rows in others The macronucleus is granular in structure and stretches almost along the entire length of the body The micronucleus is fusiform and lies near the posterior end of the macronucleus or sometimes near its middle

Keilin (1920) found in many specimens obtained from the alimentary canal of *Allolobophora caliginosa* Sav, collected near Paris, a ribbon-like supplementary chromatic body, but no such body was found by Bhatia and Gulati in parasites from the alimentary canal of *Pheretima posthuma* (L Vaill) and *P hawayana* (Rosa) examined at Lahore

Heidenreich (1935) has described the structure of the fixation apparatus, and shown it as consisting of an ectoplasmic spike with which are connected a number of skeletal rods lying in the endoplasm

Habitat—In the alimentary canal of *Pheretima posthuma* (L Vaill) and *P hawayana* (Rosa) PUNJAB, Lahore

INCERTÆ SEDIS

Genus **CAUDALINA** Madhava Rao, 1928

Caudalina, Madhava Rao, 1928, p 115

Remarks—Madhava Rao described the two following species as new and belonging to a new genus which he named *Caudalina* He has referred this genus to the family Discophryidæ in the suborder ASTOMATA Cépede (1923) changed the name of this family to Haptophryidæ This family includes intestinal parasites of Turbellaria or Batrachia with an oval nucleus, a laterally situated, elongated, and contractile excretory vessel, and an anterior sucker (except in *Lachmanella*) The two species described by Madhava Rao possess none of these characters His forms are not intestinal parasites, the macronucleus is not described as oval, the single contractile vacuole is not elongated and canal-like, and there is no anterior sucker The forms are so imperfectly described that they will have to be re-examined before their correct systematic position can be determined

120 **Caudalina armata** Madhava Rao (Fig 100)

†*Caudalina armata*, Madhava Rao, 1928, p 115, pl iii, figs 6 & 8

Body elongated, tapering at either end, broadest at about one-third of the length of the body from the posterior end, and from this part two arm-like processes arise These processes are bent and help in locomotion Cilia throughout

Fig 100

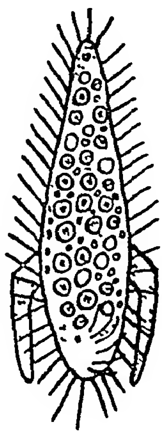


Fig 101

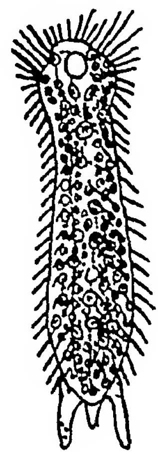


Fig 100 —*Caudalina armata* Madhava Rao (After Madhava Rao)
Fig 101 —*Caudalina bangalorensis* Madhava Rao (After Madhava Rao)

the margin of the body, and on the outer margin of the food-groove (?) No well-defined cytopharynx (?) Contractile vacuole single Nuclei two (?)

Dimensions —Length 80μ, maximum width 20μ

Habitat —Soil MYSORE, Bangalore

121 **Caudalina bangalorensis** Madhava Rao (Fig 101)

†*Caudalina bangalorensis*, Madhava Rao, 1928, p 115, pl iii, fig 7

Body elongated, with the anterior end widened into a pentagonal disc, with a slight neck-like constriction behind it, widest in the posterior part and tapering posteriorly There are two tapering arm-like processes at the posterior end which help in locomotion Between these two there are two more very small processes similar in appearance Cilia in longitudinal rows, elongated and closer round the anterior end Contractile vacuole near the anterior end Macro-nucleus nearly central, with an adjacent micronucleus

Dimensions —Length 90μ

Habitat —Soil MYSORE, Bangalore

II Order SPIROTRICHA Butschli, emend Kahl

This order includes all those Ciliates which possess a row of differentiated aggregates of cilia, known as the adoral zone of membranelles, extending from the anterior end of the body to the cytostome The individual membranelles are transversely placed and are like little plates formed by the fusion of two to four rows of cilia In this order the adoral zone is usually described as wound to the left This is true if the oral end of the zone is regarded as the beginning But as the zone does not grow out from the cytostome but rather leads to it and plays the physiological rôle of carrying the food to the cytostome in a whirlpool, it would be more reasonable, according to Reichenow, to regard its aboral end as its commencement So regarded, the adoral zone may be said to be wound to the right, that is, in a clockwise direction

The order is divided by Reichenow into five suborders, as follows —

I Heterotricha Stein
II Oligotricha Butschli
III Entodiniomorpha Reichenow
IV Ctenostomida Lauterborn
V Hypotricha Stein

Identification Table of Suborders

1 (8)	Mostly possessing free cilia Only exceptionally small groups of cirri are present, but even then in addition to free cilia	*2*
2 (3)	Body uniformly covered by fine cilia, which may be variously reduced Peristome moderate in extent	**Heterotricha**, p 210
3 (2)	Body cilia very much reduced or completely absent	4
4 (5)	Small, laterally flattened, with long cilia confined to a few rows or groups, especially at the posterior end Pellicle covered with armour plates Cytostome with a comb like structure Adoral zone limited to 8 membranelles which are situated in a groove opening ventralwards	**Ctenostomida**, p 360.

5 (4)	Body cilia strongly reduced, in some completely absent, so that the adoral zone only is present Ciliary structures often modified into bristles or cirri	6
6 (7)	Body round in cross section, with cilia greatly reduced or none at all Adoral zone forms a nearly complete or quite complete ring around the margin of the peristome, which is usually at right angles to the long axis of the body Fresh water or marine	Oligotricha, p 267
7 (6)	Body oval, often dorso ventrally flattened, usually with posterior spines or postero lateral appendages Adoral zone forms a nearly complete or complete ring around the margin of the peristome, and there may be an additional incomplete or complete ring of dorsal membranelles posterior to the adoral zone	Entodiniomorpha, [p 273
8 (1)	Body usually flattened dorso-ventrally, bearing motile organs only on the ventral surface, where there may be rows of cilia, or cilia and cirri, or the cirri may be grouped as frontals, ventrals, anals, caudals, etc One or more undulating membranes may be present in the peristome in addition to the adoral zone Short, stiff, tactile bristles may be present on the dorsal surface	Hypotricha, p 361

1. Suborder *HETEROTRICHA* Stein

Body is uniformly covered with fine cilia, which, however, may be reduced An adoral zone of membranelles extends from the anterior end of the body to the cytostome, and beginning with the aboral end is wound, as in other suborders of SPIROTRICHA, to the right Various forms are assumed by the body, according as the peristomial field is at right angles to the long axis of the body or parallel with it

The HETEROTRICHA are here arranged in accordance with the classification adopted by Reichenow and Kahl Out of the ten families, representatives of seven, viz, Spirostomidæ, Plagiotomidæ, Condylostomidæ, Stentoridæ, Folliculinidæ, Bursaridæ, and Balantidiidæ have been found in India, no representatives of Metopidæ, Reichenowellidæ, and Licnophoridæ have so far been recorded Kahl has included the family Peritromidæ also under this order, but, in accordance with general usage, it will be treated under HYPOTRICHA in this work

Identification Table of Families

1 (15) Peristomial surface unciliated — 2

2 (9 or 14) Peristome elongate and groove-shaped, with the adoral zone running from the anterior end to the cytostome near the centre of the body — 3

3 (6) Peristome with adoral zone runs straight backwards on the ventral side, and bends round to the right shortly in front of the oral funnel — 4

4 (5) Oral funnel completely absent Cytostome cleft like, near the adoral zone, but usually firmly closed and not recognizable, no undulating membrane — **Reichenowellidæ** * [Kahl

5 (4) Oral funnel generally distinct, in the typical genera an undulating membrane or a bi seriate ciliary row extends forwards from the cytostome to the right margin of the peristomial groove — **Spirostomidæ** Kent, [p 212

6 (3) Peristome does not run straight backwards — 7

7 (8) Zone of membranelles runs diagonally from left to right over the ventral surface to the posteriorly situated oral funnel, right peristomial margin provided with an undulating membrane and row of cilia, body spirally twisted — **Metopidæ** * Kahl

8 (7) Endoparastic, form oval to bean-shaped, cilia along right peristomial margin absent — **Plagiotomidæ** Poche, [p 218

9 (2) Peristome somewhat triangular, the broader field anterior — 10

10 (11) Peristome only slightly sunken, zone of membranelles surrounds in a strong curve an unciliated peristomial field, the right margin provided with an undulating membrane — **Condylostomidæ** Kahl, [p 231

11 (10) Peristome usually deeply sunk — 12

12 (13) Peristome forming a sac like depression of the anterior end, which is provided with a ventral slit Zone of membranelles runs in this depression and is continued into the bent oral funnel — **Bursaridæ** Perty, [p 240

13 (12) Peristome forms a cleft, broader anteriorly and extending from the anterior pole of the body, more or less backwards, towards the ventral surface Dorsal wall of the peristome provided with an adoral row of long cilia Cytostome at the bottom of the peristome may be followed by a distinct cytopharynx Endoparasitic — **Balantidiidæ** Reiche [now, p 244

14 (2) Body divisible into three parts, an anterior adhesive disc enclosed by four ciliary wreaths, a slender neck

	carrying an undulating membrane but no cilia, and a peristomial disc Peristome unciliated, but surrounded by spirally wound zone of membranelles Ectoparasitic on various marine animals	**Licnophoridæ*** Stevens
15 (1)	Peristomial surface ciliated, no undulating membrane	16
16 (17)	Peristome drawn out into two wings, the zone of membranelles continued along the margin of both, living in pseudochitinous test, marine	[p 238 **Folliculinidæ** Dons,
17 (16)	Peristomial surface at right angles to the long axis of the body, or at a marked angle with such axis, free or in gelatinous tests ..	[p 233 **Stentoridæ** Claus

1. Family SPIROSTOMIDÆ Kent, 1881

Peristome elongate and groove-shaped The adoral zone runs straight from the anterior end of the body towards the cytostome near the centre of the body, and bends round to the right shortly in front of the oral funnel Oral funnel generally distinct An undulating membrane or a bi-seriate ciliary row extends forwards from the cytostome to the right margin of the peristomial groove

Key to Indian Genera

1	Right peristomial margin provided with an undulating membrane in front of the cytostome, body pointed anteriorly	BLEPHARISMA, p 212
2	No undulating membrane in front of the cytostome, worm like contracting in a screw-like manner	SPIROSTOMUM, p 213

Genus BLEPHARISMA Perty, 1849

Bursaria, part, Ehrenberg, 1838, p 325, Dujardin, 1841, p 508
Blepharisma, Perty, 1849, p 170, 1852, p 137, Stein, 1867, p 177, Kent, 1880–2, p 585, Butschli, 1887–9, p 1721, Roux, 1901, p 77, Hickson, 1903, p 405, Lepsi, 1926*a*, p 65, Calkins, 1926, p 408, Schoenichen 1927, p 217, Reichenow, 1929, p 1185, Kahl, 1930–5, p 442

Bodily form persistent, almost lanceolate, strongly flattened laterally, anterior end pointed, sickle-shaped, and curved towards the ventral side Dorsal side more bulging than the ventral side Body cilia long, fine, situated in longitudinal rows Peristome narrow, extending up to the middle of the

body and widening posteriorly, left margin with well-developed adoral zone, right margin with posteriorly a short undulating membrane, which is rolled upon itself, and consequently appears like a bristle Cytostome at the posterior end of the peristome Cytopharynx generally short Contractile vacuole single, posterior Anus terminal Macronucleus rounded, oval, bipartite, or moniliform Locomotion moderately quick, with rotation on its long axis Feeding on bacteria, fungi, etc Colourless or red

122 **Blepharisma** sp (Fig 102)

Blepharisma sp, Chaudhuri, 1929, p 60, pl iii, figs 1 & 2

Fig 102 —*Blepharisma* sp (After Chaudhuri)

Habitat —Lumpy soil CENTRAL INDIA, Indore

Genus **SPIROSTOMUM** Ehrenberg, 1833

Spirostomum Ehrenberg, 1833, p 252, 1835, p 165, 1838, p 332, Dujardin, 1841, p 514, Claparède & Lachmann, 1858–61, p 231, Stein, 1867, p 187, Fromentel, 1874, p 175, Kent, 1880–2, p 586, Butschli, 1887–9, p 1723, Roux, 1901, p 79, Hickson, 1903, p 405, Minchin, 1912, pp 438, 439, 445, Calkins, 1926, p 408, Lepsi, 1926 *a*, p 64, Wenyon, 1926, p 1197, Schoenichen, 1927, p 219, Reichenow, 1929, p 1185, Kahl, 1930–5, p 437

Animalcules free-swimming, very large, highly elastic, contractile and flexible, very elongated, cylindical or somewhat flattened, anteriorly rounded, posteriorly truncated Peristome long, extending down the left side of the ventral surface as far as or beyond the middle of the body, widest at this point and continued inward as a short funicular cytopharynx, adoral cilia bordering the outer or left-hand side only of the peristomial area, no undulating membrane Contractile vacuole taking up the whole of the posterior end of the body

and continued forwards as a straight canal extending along the whole length of the body Macronucleus ovate or moniliform Micronuclei numerous Locomotion very active, followed by contractions and often by a spiral twisting on its long axis Inhabiting fresh water Feeding on algæ, detritus, etc

Remarks—According to Ann Bishop (1927) there is no undulating membrane According to Kahl (1932) there is an undulating membrane, composed of two rows of short cilia, along the right wall of the peristome posteriorly and extending to the bottom of the short oral funnel

Key to Indian Species

1	Body cylindrical, length more than 500 μ, up to 4500 μ Peristome extending at least up to the middle of the body Macro nucleus rosary shaped	[p 214 *S ambiguum* Ehrbg ,
2	Body elongated, spindle shaped, length up to 450 μ Peristome only 1/3 the body length Macronucleus oval to spindle shaped	[p 217 *S teres* Cl & Lachm ,

123 Spirostomum ambiguum Ehrenberg (Fig 103)

Trachelius ambiguus, Ehrenberg, 1830, p 62 , 1831, p 107
Holophrya ambigua, Ehrenberg, 1831, p 102
Bursaria ambigua, Ehrenberg, 1831, p 132
Spirostomum ambiguum, Ehrenberg, 1835, p 165 , 1838, p 332, pl xxxvi, fig 11 , Dujardin, 1841, p 514 , Claparède & Lachmann, 1858–61, p 231 , Stein, 1859 *d*, pp 55, 60, 64, 72, 78, 80, 86, 88, 90, 95 , 1867, pp 197–208, pl ii, figs 10–11 , pl iii, figs 2–9 , pl iv, fig 1 , Balbiani, 1860 *b*, pp 77, 87 pl iv, figs 19–24 , 1861, p 107, pl ix, figs 7–9 , Pritchard, 1861 p 623, pl xxix, figs 297, 298 , Fromentel, 1874, pp 284–5 & pl xv figs 1–1 *f* , Kent, 1880–2, pp 586–7, pl xxix, figs 13 & 14 , Roux, 1901, pp 80–81, pl x fig 1 , Hickson 1903 p 406 fig 57 , Minchin, 1912, p 431, fig 180
†*Spirostomum ambiguum*, Bhatia, 1916, p 183 , Ghosh, 1921, p 10
Spirostomum ambiguum, Bishop, 1923, pp 391–434, pls xxii–xxiii , 1927, pp 147–172, pls xvii–xviii, and 3 text figs, Lepsi, 1926 *a*, p 69, figs 305, 306 , Wenyon, 1926, p 1197, fig 509 , Kahl, 1926, pp 420–1, fig Y 3 *a–b* , Schoenichen, 1927, p 219, fig 740 and pl xii, fig 50 , Reichenow, 1929, p 1186, fig 1167 A & C
†*Spirostomum ambiguum*, Bhatia & Mullick, 1930, p 399
Spirostomum (Trichoda) ambiguum Kahl, 1930–5, p 437, fig 72, *1*
Spirostomum minus, Kahl, 1930–5, p 440, fig 72, *2*

Body elongate, thread like, from ten to twenty times or more as long as broad, nearly or entirely cylindrical, the anterior and posterior extremities often equally rounded, or the posterior one occasionally truncated Peristome

extending quite to the centre of the body, or even beyond this point Contractile vacuole single, taking up the whole of the posterior end of the body, and extending forward as a straight canal Macronucleus elongated, moniliform Micronuclei numerous In pond water among aquatic plants

Fig 103

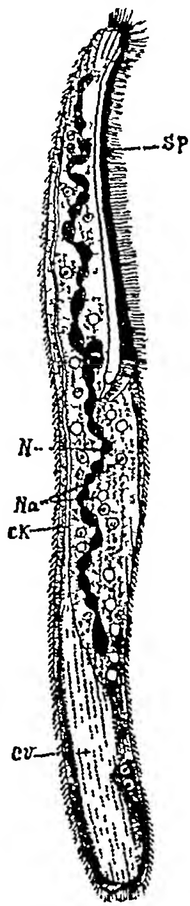


Fig 104

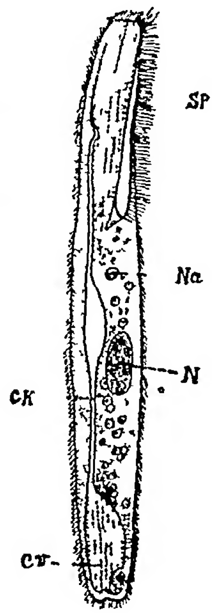


Fig 103 —*Spirostomum ambiguum* Ehrbg *ck*, canal extending forward from the vacuole, *cv*, contractile vacuole, *N*, macronucleus, *Na*, food-vacuole, *Sp*, adoral zone (After Stein)

Fig 104 —*Spirostomum teres* Cl & L Lettering as in the preceding figure (After Stein)

Dimensions —Length of the extended body 500–800μ (var *minor*), 3–4 5 mm (var *major*)

Remarks —Fairly commonly found in pond water in which aquatic plants are growing The animalcules, being of such a large size, are easily visible to the naked eye and appear to

be thread-like bodies moving about actively The specimens sometimes show a spiral twisting of the body upon their long axis, as figured by Kent (plate xxix, fig 14) According to Roux a smaller form of *S ambiguum*, from 500–600μ in length, is recognized as var *minor* The peristome is shorter than in the typical form, and does not extend beyond the middle of the body Specimens found at Lahore have often measured more than 600μ, but never exceeded 800μ, and have therefore been referred to var *minor* Kahl (1930–5) considers this a distinct species and describes it as *S minus* Roux

The macronucleus is usually moniliform and runs through the greater part of the body The beads are rounded, oval, or elongated-oval and tapering at either end, they are usually connected together by elongate and narrow commissures Each lobe or bead of the nucleus is seen, in preparations stained with iron-hæmatoxylin, to contain a number of larger granules (macrosomes) which are vacuolated, and a number of smaller granules (microsomes), these latter are more deeply stained in borax-carmine preparations The micronuclei are numerous, but usually less in number than the lobes of the macronucleus Each micronucleus consists of a deeply staining granular mass surrounded by a clear non-staining halo The micronuclei are not in contact with the lobes of the macronucleus, but are situated at some distance from them

The form and structure of the macronucleus vary a good deal in different specimens In some specimens it is vermiform, resembling a band, which is twisted in its course In some the band is very much shortened, and in still others there is an approach to the oval nucleus resembling that of *S teres* In the larger specimens the macronucleus is always moniliform, and the shape and size of the beads vary a good deal occasionally there are no visible commissures, and the lobes of the macronucleus appear to be discrete These variations in form of the macronucleus are to be regarded as stages in growth There is no correspondence between the number of micronuclei and the lobes of the macronucleus Bhatia and Mullick (1930) have made an interesting observation regarding a correspondence between the form of the macronucleus and the length of the peristome in specimens showing a band-shaped or vermiform nucleus the peristome usually extends to about one-third of the length of the body, whereas in specimens with a moniliform nucleus the peristome reaches the middle of the body or even extends beyond it Thus *S teres*, and the *minor* and *major* varieties of *S ambiguum*, form a series, the structural peculiarities of which are closely paralleled by the stages of growth of the individual specimens of *S ambiguum*

Specimens of *S ambiguum* are longer and thicker than those of *S teres*, and can be readily recognized from the latter by the length of the peristome and the form of the macronucleus

Habitat—Pond water KASHMIR, Srinagar, PUNJAB, Lahore, BENGAL, Calcutta

124 **Spirostomum teres** Claparède & Lachmann (Fig 104)

Uroleptus filum (?), Ehrenberg, 1833, p 133, 1838, p 359, pl xl, fig v
Spirostomum filum (?), Dujardin, 1841, p 515, Claparède & Lachmann, p 233
Spirostomum teres, Claparede & Lachmann, 1858–61, p 233, pl xi, figs 1, 2, Balbiani, 1861, p 126, pl ix, figs 1–5, Kent, 1880–2, p 586, Roux, 1901, p 81, pl v, fig 2, Lepsi, 1926 *a*, p 69, figs 302–4, Kahl, 1926, p 421, fig Y 3 *e*, 1930–5, p 440, fig 72, 7, Schoenichen, 1927, p 219, Reichenow, 1929, p 1186, fig 1167 B
†*Spirostomum teres*, Bhatia & Mullick, 1930, p 399

Body elongated, spindle-shaped, flattened Peristome generally extending up to one-third the length of the body only, anterior end narrower, posterior end truncated Contractile vacuole single, occupying the whole of the posterior end of the body and extending forwards as a long canal Macronucleus oval to spindle-shaped, central

Dimensions—Length 150–450 μ

Remarks—Specimens were found in pond water, overgrown with *Lemna* and other aquatic plants, at Srinagar The peristomial groove extends only up to about one-third of the length of the body The macronucleus is oval Sometimes there are two oval macronuclei lying in the centre, closely approximated to each other each of these contains a large number of rounded microsomes

Habitat—Pond water KASHMIR, Srinagar

125 **Spirostomum** sp

†*Spirostomum* sp, Chaudhuri, 1929, p 54, pl ii, fig 25

Habitat—Soil CENTRAL INDIA, Indore, Madras, Hyderabad, UNITED PROVINCES, Agra

2. Family PLAGIOTOMIDÆ Poche, 1913, emend. Kahl.

Form of the body oval or bean-shaped Peristome does not run straight backwards Cilia along the right peristomial margin absent Endoparasitic

Genus **NYCTOTHERUS** Leidy, 1849

Nyctotherus, Leidy, 1849, p 233, 1850, p 158, 1853, p 241, Stein, 1867, p 335, Kent, 1880–2, p 579, Butschli, 1887–9, p 1721, Hickson, 1903, p 405, Minchin, 1912 pp 439, 440, 447, Hegner & Taliaferro, 1924, pp 433–5, Calkins, 1926, p 408, Lepsi, 1926*a*, p 66, Wenyon, 1926 p 1198, Bhatia & Gulati, 1927, p 112, Grassé, 1928 p 55, Knowles, 1928, p 523, Reichenow, 1929, p 1186, Thomson & Robertson 1929, pp 274–5

Body flattened, oval or kidney-shaped, a notch or concavity occurring near the middle of the right side, the dorsal side is strongly convex, the ventral bent inwards in the middle, peristome commencing a little behind the anterior extremity and continued in a cleft-like manner on the ventral side to the centre of the body The body is covered with cilia, and in front of the notch there is an adoral zone of cilia on the peristome that leads to the cytostome, an opening situated in the notch The cytostome is continued into a long curved cytopharynx, on the anterior wall of which is a row of parallel plates of fused cilia This row of plates extends in the adoral region nearly as far as the anterior end of the body At the hinder end of the body is the anus, continuous with a short unciliated anal tube Contractile vacuole single, opening into the upper end of the anal tube An oval macronucleus, with a micronucleus lying close to it, is situated in front of the cytopharynx In some species the macronucleus is provided with a caryophore, or nuclear stalk Occurring as parasites within the intestine of Amphibia and of various groups of Invertebrata

Remarks—Grassé (1928) has split the genus according to the presence or absence of the caryophore or nuclear stalk (Aufhangeapparates) into the subgenera *Nyctotherus* s str and *Nyctotheroides*, to the latter would belong the species occurring in Amphibia and *N tipula* This splitting of the genus is not followed in this work

Key to Indian Species *

1 (7)	Cytopharynx transversely or obliquely directed and reaching the middle	2
2 (5)	Body ovoid	3
3 (4)	Body broadly egg shaped Macronucleus egg shaped Length very variable, 70–360 μ	*N ovalis* Leidy, p 226.
4 (3)	Body ovoid Cytopharynx slightly curved Macronucleus ovoid or slightly horseshoe-shaped Length 60–70μ	*N termitis* Dobell, [p 229.
5 (2)	Body reniform	6
6	Cytopharynx curved in a semicircle, with a diverticulum at its junction with the cytostome Macronucleus reniform or horseshoe shaped Length 120–170 μ	*N papillatus* Dobell, [p 228
7 (1)	Cytopharynx reaching beyond the middle of the body	8
8 (11)	Cytopharynx shorter than the transverse diameter of the body	9
9 (10)	Cytopharynx slightly curved, with the concavity directed forwards Body elongated Macronucleus elongately oval Length 170 μ	*N kempi* Ghosh, p 221.
10 (9)	Cytopharynx broadly curved posteriorly Body kidney-shaped Length 160–180 μ (Bezz) or 71–111 μ (Stein) Breadth $\frac{2}{3}$–$\frac{3}{4}$ of the body-length Macronucleus kidney shaped	*N cordiformis* (Ehrbg), [p 220.
11 (8)	Cytopharynx nearly equal to or longer than the transverse diameter of the body	12
12 (15)	Cytopharynx nearly equal to the transverse diameter of the body	13
13 (14)	Cytopharynx with a bow directed ventralward, and with its tip directed forward	
	a Body kidney shaped, 660 μ by 460 μ Macronucleus flattened lengthwise	*N magnus* Bezz , [p 224.
	b Body ovoid, 130–230 μ by 80–145 μ. Cytopharynx forming a sharp angle with the peristome Macronucleus a triangular mass	*N magnus* v *mala* [*barica* De Mello, [p 225.
14 (13)	Cytopharynx extending obliquely backward, reaching about $\frac{1}{5}$ of the length of the body from the posterior end Body kidney-shaped Macronucleus large and ovoid Length 92 μ	*N reniformis* Bhatia & [Gulati, p 229
15 (12)	Cytopharynx longer than the transverse diameter of the body	16
16	Cytopharynx spirally rolled Macronucleus irregular shaped Body egg-shaped, 350 μ by 220 μ	*N macropharyngeus* [Bezz , p 222.

* A key to all the species of the genus known up to 1926 and the list of hosts are given by Bhatia & Gulati (1927)

126 **Nyctotherus cordiformis** (Ehrenberg) Stein (Fig 105)

Bursaria cordiformis, Ehrenberg, 1838, p 328, pl xxxv, fig vi, 1–4, Stein, 1854, pp 42, 183, 1856, p 36
Plagiotoma cordiformis, Claparède & Lachmann, 1858–61, p 236, pl xi, figs 8, 9, Stein, 1859 *d*, pp 78, 81, 84, 85, 90
Nyctotherus cordiformis, Stein, 1867, pp 338–44, pl xv, figs 1–10, Kent, 1880–2, p 580, pl xxix, fig 4, Bezzenberger, 1904, p 149, Minchin, 1912, pp 10, 444, figs 9, 186 F
†*Nyctotherus cordiformis*, Ghosh, 1921 *a*, p 10
Nyctotherus cordiformis, Hegner & Taliaferro, 1924, p 434, fig 169, Wenyon, 1926, p 1199, fig 511
†*Nyctotherus cordiformis*, Bhatia & Gulati, 1927, p 115
Nyctotheroides cordiformis, Grassé, 1928, pp 55–68, Knowles, 1928, p 523, figs 36, 132, Reichenow, 1929, p 1187, Thomson & Robertson, 1929, fig 182
†*Nyctotherus cordiformis*, De Mello, 1932, pp 100–1, 111 113–14, 116, 124, pls xii, fig 1, xiv, fig 1

Body bean- or kidney-shaped, somewhat pointed anteriorly, much compressed, the breadth equal to two-thirds or three quarters of the total length Cytopharynx reaching beyond the middle of the body, shorter than the transverse diameter of the body, broadly curved, with opening behind Contractile vacuole single, postero-terminal, with anal aperture close to it Macronucleus kidney-shaped, with a minute centrally attached micronucleus

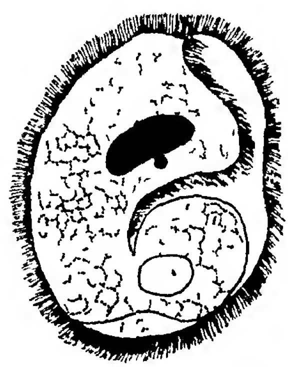


Fig 105 —*Nyctotherus cordiformis* (Ehrbg) (After de Mello)

Dimensions —Length usually between 80–220μ Cyst ovoid, 80–90μ in length, containing a single individual

Remarks —Bezzenberger (1904) in his identification table gives 160–180μ as the length for this species and the width as two-thirds to three-quarters of the length The specimens found at Lahore were considerably smaller, and measured 95μ by 75μ these dimensions, however, fall within the limits of those given by Stein (1867) De Mello gives the length as minimum 88μ, maximum 325μ, and usually between 100–220μ, in specimens from *Bufo melanostictus*, and minimum 45μ, maximum 150μ, usually between 80–125μ, in

specimens from *Rana malabarica* The cytopharynx was nearly straight, shorter than the transverse diameter of the body, and bending only slightly at its inner end Grassé (1928) referred this species to the subgenus *Nyctotheroides*, and observed anisogamous conjugation in this species

Habitat —Intestine and cloaca of *Bufo melanostictus* Schneid PUNJAB, Lahore, BENGAL, Calcutta, NOVA GOA Intestine of *Rana tigrina* Daud, *R malabarica* Tsch, *R limnocharis* Wiegm NOVA GOA

127 **Nyctotherus kempi** Ghosh (Fig 106)

†*Nyctotherus kempi*, Ghosh, 1921 *a*, pp 10–11, fig 11
Nyctotherus kempi, Bhatia & Gulati, 1927 p 177, Reichenow 1929, p 1187

Body elongate, about thrice as long as broad, much flattened dorso-ventrally, specially in the anterior half, highly flexible

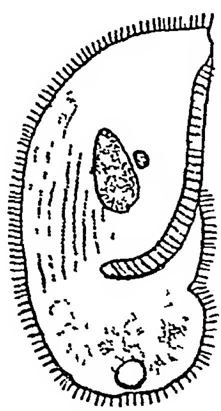


Fig 106 —*Nyctotherus kempi* Ghosh (After Ghosh)

Anterior end tapering to a point, posterior end rounded Left side convex Right side more or less straight, sometimes with a shallow notch in the posterior region Peristome linear, along the right side and extending beyond the middle of the body Cytopharynx about half the diameter of the body. Longitudinal ciliary lines distinct and close to one other, all converging in front to the anterior beak Endoplasm clear in the anterior third of the body and on the left side, coarsely granular in remaining portion Contractile vacuole single, small, at the posterior end of the body Macronucleus elongately oval, in front of the middle Micronucleus adjacent

Dimensions —Length 170μ, width 84μ

Remarks —The body is so highly flexible that the anterior half is sometimes doubled over the posterior portion

Dr H N Ray, who has re-examined the form, has informed me in a personal communication that Ghosh's description of the species needs correction in certain respects According to him the anterior end of the body is rounded and only slightly narrower than the posterior end, the peristome extends into the posterior third of the body, the cytopharynx is more than half the diameter of the body and is directed backwards the macronucleus is broadly elliptical, and placed obliquely about the middle of the body, and the micro nucleus is placed at the posterior end of the macronucleus

Habitat —Rectum of *Pila* (*Ampullaria*) *globosa* (Swainson) BENGAL, Calcutta

128 **Nyctotherus macropharyngeus** Bezzenberger (Fig 107)

†*Nyctotherus macropharyngeus* Bezzenberger, 1904, pp 141 4, figs 1–3, Dobell, 1910, p 75, Ghosh, 1921 *a*, p 10
Nyctotherus macropharyngeus, Hegner & Taliaferro, 1924, p 435, Wenyon, 1926, pp 1199–1200
†*Nyctotherus macropharyngeus*, Bhatia & Gulati, 1927, pp 114–15
Nyctotheroides macropharyngeus, Grasse, 1928, pp 55 68
†*Nyctotherus macropharyngeus* De Mello, 1932, pp 109–11, 116–17, 118, 124, pl xiii, fig 9 Gulati, 1933, pp 367–9, 2 text figs

Body egg-shaped, pointed anteriorly, length of the body about one and a half times the width Cytopharynx reaching beyond the middle of the body, substantially longer than the transverse diameter of the body, spirally coiled Contractile vacuole single or 2 to 3, posterior Macronucleus irregularly shaped, with micronucleus above it or close to it

Dimensions —Length, minimum 140μ, maximum 360μ, macronucleus 60–100μ in length by 38–50μ in width in specimens from *R tigrina*, length, minimum 90μ, maximum 380μ, usually between 80–335μ, in specimens from *R limnocharis*

Remarks —The body is sometimes oval, highly convex along one margin The posterior part of the body is distinctly thicker than the anterior part, and at the anterior end a thinner portion appears to project like a frill The dorsal surface of the body is convex, and the ventral flattened or somewhat concave An individual appears to be composed of two oval flaps placed over one another, with one of them projecting at the anterior end The peristome commences a little behind the anterior end and is continued on the ventral side to the centre of the body and there is bent inwards to meet the well-developed cytopharynx Only the left border of the peristome is provided with specially strong membranelles, which are continuous with the cilia in the cytopharynx The cytopharynx is a large funnel-shaped tube, the posterior

portion of which is coiled upon itself in 2 or 2½ spiral turns The anterior wall of the cytopharynx is throughout provided with specially strong cilia

The cytoplasm is clearly marked off into cortical and medullary portions The ectoplasm is narrow, and the basal granules of the cilia are large and very compactly arranged The whole surface of the body is covered with short fine cilia arranged in oblique lines, which are very close to each other The contractile vacuole is very slow in its pulsations and empties itself through the anal opening The anal tube does not appear to be always present

The endoplasm is coarsely granular The macronucleus and the micronucleus are situated in the anterior half of the

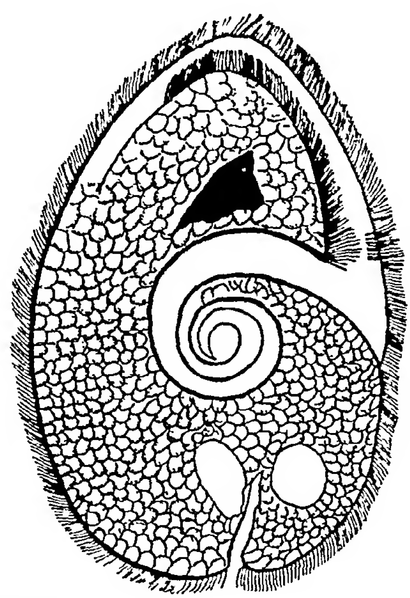


Fig 107 —*Nyctotherus macropharyngeus* Bezz (After de Mello)

body The form of the macronucleus varies a good deal, being pentagonal, like a trapezium, oval, or cone-shaped, with the apex of the cone directed to one side It shows a finely granular structure with one or more karyosomes The micronucleus is usually placed over the macronucleus, but less frequently lies close beside it Mitochondria are seen as small spherical particles scattered about in the cytoplasm The specimens found at Lahore were smaller in size than those described by Bezzenberger an average specimen measured 207 μ in length and 142 μ in width, the macronucleus being 40 μ in length by 39 μ in width

Gulati (1933) has described transverse binary fission and isomorphic conjugation in this species

Habitat —Cloaca of *Rana tigrina* Daud BENGAL, Calcutta, BOMBAY, CEYLON, Colombo Cloaca of *R tigrina* Daud, *R cyanophlyctis* Schneid, and *R hexadactyla* Lesson PUNJAB, Lahore Intestine of *R tigrina* Daud, *R limnocharis* Wiegm, and *R cyanophlyctis* Schneid NOVA GOA

129 **Nyctotherus magnus** Bezzenberger (Fig 108)

†*Nyctotherus magnus*, Bezzenberger 1904, pp 145–8, figs 5–8
Nyctotherus magnus Hegner & Taliaferro, 1924, p 435, Wenyon 1926, p 1199

Body flattened, kidney-shaped, with the posterior end only slightly thicker than the anterior, possessing a semi-lunar

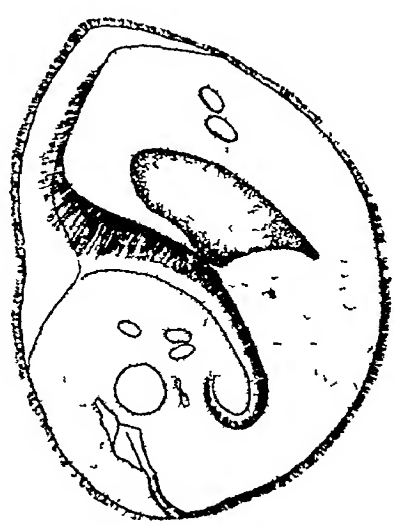


Fig 108 —*Nyctotherus magnus* Bezz (After Bezzenberger)

frill-like extension at the anterior end Cilia short and fine, arranged in rows and arising from large basal granules Cytopharynx funnel-shaped, approximately as long as the transverse diameter of the animal, describing a bow with the opening directed ventralwards, and the end inflected forward The entire left margin of the peristome and the cytopharynx bear membranelles The right peristomial border bears cilia which are longer than the body cilia Contractile vacuole single, situated in the posterior part of the body and emptying itself into a slit-like anal tube Macronucleus strongly flattened in its long direction, and lying in front

of the cytopharynx Micronucleus lies against the concave surface of the macronucleus

Dimensions —Length 660μ, width 460μ

Habitat —Cloaca of *Rana hexadactyla* Lesson Asia (exact locality not cited by Bezzenberger)

130 **Nyctotherus magnus** var **malabarica** de Mello (Fig 109)

†*Nyctotherus magnus* var *malabarica*, de Mello, 1932, pp 111, 112, 124, pl xiii, figs 10, 11

Body ovoid, with the anterior pole slightly narrower and more pointed than the posterior pole, which is wider and regularly rounded Peristome wide, commencing a little to one side of the anterior pole, regularly rounded anteriorly, and with its internal margin parallel to the external border of the body, making with the cytopharynx a sharp angle Cytopharynx

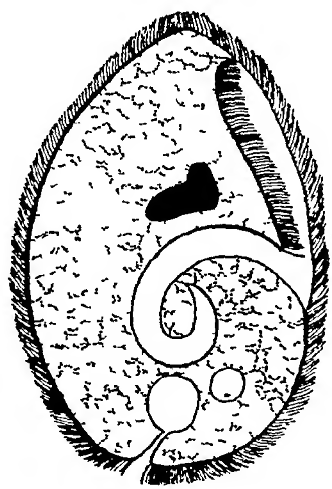


Fig 109 —*Nyctotherus magnus* v *malabarica* de Mello (After de Mello)

extending beyond the middle of the body, as long as the transverse diameter of the body, fissure-like, describing a regular curve with its opening directed ventralwards. Cuticle marked by transverse sinuous striations Contractile vacuole single, connected with the anal groove Macronucleus irregularly ovoid, generally presenting the form of a triangular mass, with its wide base directed towards the anterior border of the cytopharynx Micronucleus an oval mass lodged in the parenchyma of the macronucleus

Dimensions —Length, minimum 130μ, maximum 230μ, average 150–155μ , width, minimum 80μ, maximum 145μ, average 110μ , macronucleus 45 by 30μ

Habitat —Intestine of *Rana tigrina* Daud NOVA GOA

131 **Nyctotherus ovalis Leidy** (Fig 110, A & B, 111)

Nyctotherus ovalis, Leidy, 1849, p 233, 1850 *a*, p 100
Plagiotoma blattarum, Claparède & Lachmann, 1858–61, p 240
Bursaria blattarum, Stein, 1854, p 42
Plagiotoma blattarum, Stein, 1859 *d*, pp 78, 81, 84, 85, 90
Nyctotherus ovalis, Stein, 1867, pp 344–7, pl xv, figs 11–16, Kent, 1880–2, p 580, Butschli, 1887–9, pl lxvi, fig 6, Bezzenberger, 1904, p 149
†*Nyctotherus ovalis*, Ghosh, 1921 *a*, p 10
Nyctotherus ovalis, Wenyon, 1926, p 1200, Lepsi, 1926 *a*, p 67, fig 272, Calkins, 1926, p 145, fig 74, *D*
†*Nyctotherus ovalis*, Bhatia & Gulati, 1927, p 116, de Mello, Carvalho & Gaitondó, 1934, pp 249–57, figs 1–5

Body broadly egg-shaped, often scarcely longer than broad, the anterior extremity rounded Body divided into two parts

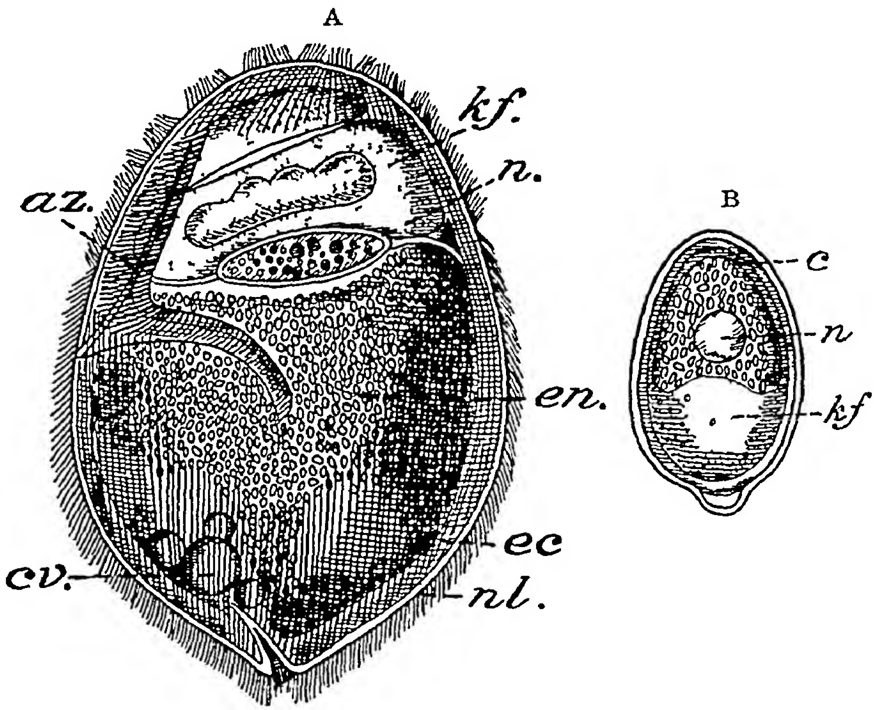


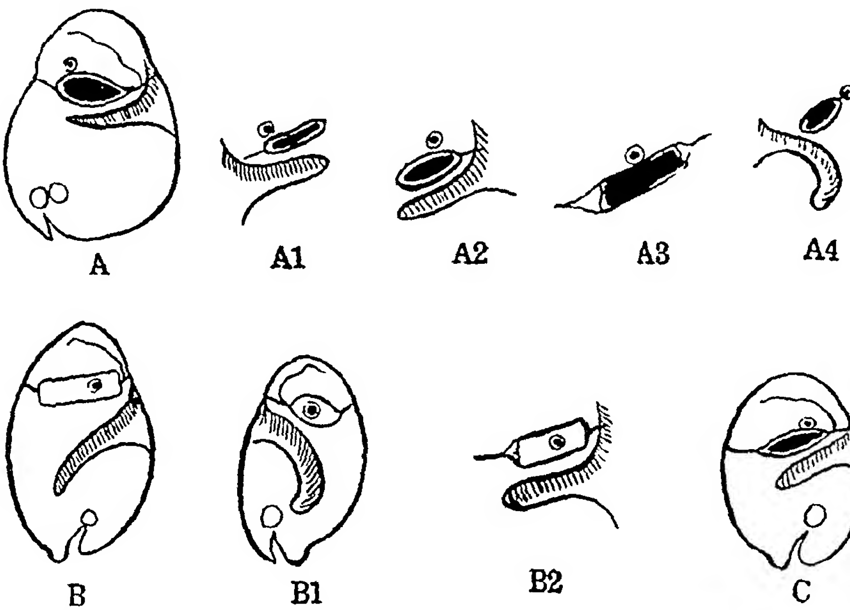
Fig 110 —A *Nyctotherus ovalis* Leidy *az*, adoral zone, *cv*, contractile vacuole, *ec*, ectoplasm, *en*, endoplasm, *kf*, granular field, *n*, macronucleus, *nl*, pellicle B *Nyctotherus ovalis* Leidy, cyst, *c*, cyst wall, *n*, macronucleus, *kf*, granular field (From Bütschli, after Stein)

by a caryophore diaphragm, one anterior, smaller, transparent and of finely alveolar structure, the other posterior, infranuclear, occupying more or less two-thirds of the length of the body, formed of large alveoli, and containing numerous

inclusions and foreign bodies Cytopharynx not reaching beyond the middle of the body, transverse in direction, extending slightly beyond the posterior opening of the bow and reaching up to the middle Contractile vacuole single, subterminal Macronucleus egg-shaped, curved

Dimensions —Length very variable, from 70 to 360μ

Remarks —Grassé (1928) recognized in this species a caryophore or suspensor of the macronucleus, composed of separate fibrils connecting the macronucleus with the body-wall, and restricted the name *Nyctotherus* to a subgenus that includes those species in which this structure is found More recently Froilano de Mello and others (1934) have described in detail



A A1 A2 A3 A4 B B1 B2 C

Fig 111 —Morphological types of *Nyctotherus ovalis* Leidy (After de Mello, Carvalho and Gaitonde)

the structure of this caryophore diaphragm with its frontal lamina, as well as of the neuromotor apparatus attached as an appendix to the cytopharynx, and the fibrillæ in the lumen of the cytopharynx They recognize three morphological types among the different specimens of this species (fig 111) (A) those with micronucleus separate from macronucleus, and anal groove simple, (B) those with micronucleus embedded in the mass of the macronucleus, anal groove with one border protruded into a nipple-like point, and (C) a transitional type with nuclear apparatus as in (A) and anal groove as in (B)

Habitat —Mid-gut and hind-gut of *Periplaneta americana* Punjab, Lahore, Nova Goa, Bengal, Calcutta

132 **Nyctotherus papillatus** Dobell (Fig 112)

†*Nyctotherus papillatus*, Dobell, 1910, p 76
Nyctotherus papillatus, Wenyon, 1926, p 1200, Bhatia & Gulati, 1927, p 117
†*Nyctotherus papillatus*, de Mello, 1930, pp 951–2, 1931 *a*, p 1184, 1931 *b*, pp 1440–1, 1932, pl xii, fig 2

Body reniform Cytopharynx extends to the median line, is sharply curved into an almost perfect semicircle, and has a well-marked spiral twist Anus opens just dorsally to a well-marked papilla at the extreme posterior end of the animal Contractile vacuole single, close to the anus Macronucleus anterior, reniform or horseshoe-shaped, with the ends

Fig 112

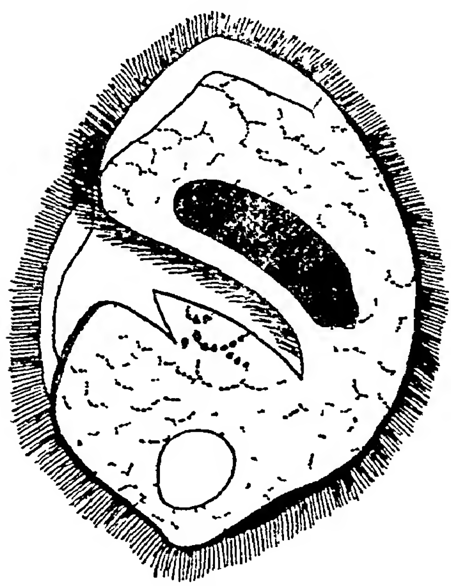


Fig 113

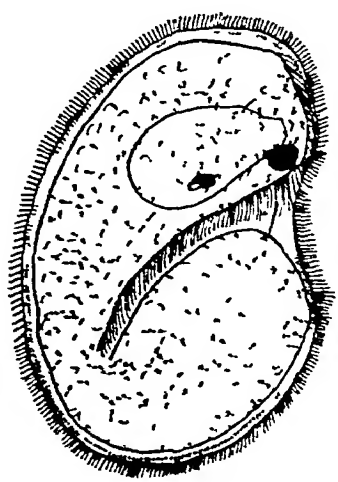


Fig 112 —*Nyctotherus papillatus* Dobell (After de Mello)
Fig 113 —*Nyctotherus reniformis* Bh & G (After Bhatia & Gulati)

directed ventrally, so that it appears ovoid when seen from the side Micronucleus not always seen, but sometimes visible lying on the macronucleus

Dimensions —Length 120–300μ

Remarks —A curious little diverticulum of the cytopharynx, situated at the point of its junction with the mouth, is nearly always present, it passes dorso-posteriorly for a very short distance De Mello has always found it in his specimens from Nova Goa The measurements of the form vary a good deal Dobell found that specimens from *Bufo melanostictus* measured *ca* 120μ in length, whilst those from *Rhacophorus*

maculatus were distinctly larger, attaining a length of 170 μ De Mello has found that his specimens from Nova Goa have much larger dimensions than those given for specimens from Ceylon, the smallest measuring 140 μ by 90 μ and the largest 300 μ by 150 μ, mostly 160–200 μ in length and 90–150 μ in width The dimensions of the macronucleus in his specimens were maximum 100 μ by 20–25 μ, minimum 50 μ by 20–30 μ

Habitat —Rectum of *Bufo melanostictus* Schneid, *Rhacophorus maculatus* (Gunther) CEYLON, Peradeniya Intestine of *Rhacophorus maculatus* (Gunther) NOVA GOA

133 **Nyctotherus reniformis** Bhatia & Gulati (Fig 113)

†*Nyctotherus reniformis*, Bhatia & Gulati, 1927, pp 115–16, fig 12

Body reniform, length about $1\frac{1}{2}$ times the width Cytopharynx extending obliquely backwards, reaching to about one-fifth of the length of the body from the posterior end Contractile vacuole single, posterior Macronucleus large and ovoidal, with a prominent micronucleus close to its pointed end

Dimensions —Length 92 μ

Remarks —The cytoplasm is clearly marked into cortical and medullary regions The cortical region forms a narrow zone round the medullary region, which is alveolar The cilia are fine and close-set On the surface of the body the cilia are arranged in oblique rows, running somewhat parallel to the cytopharynx The macronucleus is a large oval mass situated in the anterior half of the body, with its narrow pointed end directed towards one side The micronucleus is a fairly big rounded structure lying close to the pointed end of the macronucleus The dimensions of an average specimen are 92 μ by 60 μ, macronucleus, 35 μ by 17 μ

Habitat —Rectum of *Bufo macrotis* Bouleng PUNJAB, Sialkot

134 **Nyctotherus termitis** Dobell (Fig 114)

†*Nyctotherus termitis*, Dobell, 1910, p 81, fig 21
Nyctotherus termitis Wenyon, 1926, p 1200, Bhatia & Gulati, 1927 p 117, de Mello, Carvalho & Gaitondo, 1934, p 250

Body roughly ovoid, with a more or less strongly marked constriction at the level of the macronucleus, and another similar constriction half-way between this and the extreme anterior end Cytopharynx situated near the middle, running in obliquely, with a very slight curvature, not extending more than half-way across the animal Anus posterior, well

marked though narrow Contractile vacuole single, near the anus on the ventral side Macronucleus ovoid or slightly horseshoe-shaped Micronucleus seen sometimes, in close contact with the macronucleus Caryophore diaphragm present

Dimensions —Length 60–70 μ, maximum width rather more than 40 μ

Remarks —This species in general structure closely resembles *N ovalis* of the common cockroach As remarked by Dobell,

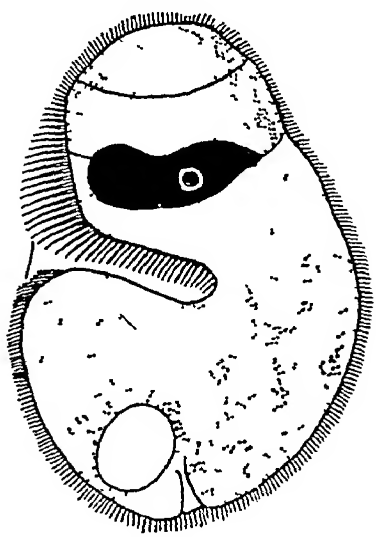


Fig 114 —*Nyctotherus termitis* Dobell (After Dobell)

it is a striking fact that the white ants should harbour a *Nyctotherus* so closely resembling that of the cockroach, when it is remembered that the Trichonymphids are also confined to these two hosts

As remarked by Froilano de Mello and others (1934), the caryophore diaphragm is shown in Dobell's figure of this species

Habitat —In the alimentary canal of *Calotermes militaris* CEYLON

3. Family CONDYLOSTOMIDÆ Kahl, 1927.

Peristome somewhat triangular, broader anteriorly, only slightly sunken Adoral zone runs in a strong curve surrounding an unciliated peristomial field The right margin of the peristome is provided with an undulating membrane

Genus **KONDYLIOSTOMA** Bory, 1824

Kondyliostoma, part, Bory, 1824, p 139
Condylostoma, Ehrenberg, 1838, pp 308, 311, 314
Kondylostoma, Dujardin, 1841, p 516
Condylostoma, Agassiz, 1846, p 96
Kondylostoma, Claparede & Lachmann, 1858–61, p 243
Condylostoma, Stein, 1867, p 171, Kent, 1880–2, p 584, Bütschli, 1887–9, p 1725, Roux, 1901, p 81, Hickson, 1903, pp 405, 406, Calkins, 1926, p 408, Lepsi, 1926 *a*, p 66 Schoenichen, 1927, p 220, Sandon, 1927, p 190, Reichenow, 1929, p 1188, Kahl, 1930–5, p 452

Body ovate or elongate and almost cylindrical, changeable in form, slightly flattened, obliquely truncate anteriorly Peristome restricted to the anterior extremity of the body, harp shaped containing within an adoral ciliary spiral and a large flap-like undulating membrane Cilia on the ventral side somewhat larger and more sparse than on the dorsal side Contractile vacuole single or multiple, sometimes associated with elongate canal-like extensions Anal aperture posteroterminal Macronucleus elongate, moniliform

Salt and fresh water Feeding on unicellular algæ, detritus, etc

135 **Kondyliostoma patens** (Muller) Dujardin (Fig 115)

Trichoda patens, Müller, 1786, p 181, pl xxvi, figs 1–2
Uroleptus (?) *patens*, Ehrenberg, 1833, p 278
Kondylostoma patens, Dujardin, 1841, p 516, pl xii, fig 2, Claparède & Lachmann, 1858–61, p 244, pl xii, fig 3
Kondylostoma patulum Claparede & Lachmann, 1858–61, p 246, pl xii, fig 4
Condylostoma patens, Stein, 1859 *d*, pp 72, 73, 78, 95, 1867, pp 173–7, pl i, figs 1–4 Kent, 1880–2, p 584, pl xxix, fig 12, Butschli, 1887–9, pl lxvii, fig 4, Lepsi, 1926 *a*, p 70, fig 315, Sandon, 1927, p 190
†*Condylostoma patens*, Madhava Rao, 1928, p 115
Condylostoma (Trichoda) patens, Kahl, 1930–5, p 453, fig 75, *1*

Body highly elastic, elongate elliptical, nearly cylindrical, length when extended equal to seven or eight times the greatest breadth, widest posteriorly, somewhat flattened anteriorly. Cuticular striæ fine, distributed equally and in parallel longi-

tudinal lines throughout the surface of the body Peristomial field an irregularly triangular or harp-shaped excavation occupying an almost median position at the anterior extremity of the ventral surface, its length equal to about one-fifth to one-sixth of the body, unciliated, undulating membrane conspicuous, extending along the entire length of the right peristomial border, its width equal to one-half of that of the peristomial field Cytopharynx narrow, tubular, equal to one-half the length of the peristome Contractile vacuole canal-like, often breaking up into vesicular spaces, extending along the left border Macronucleus elongate, moniliform, located towards the right side

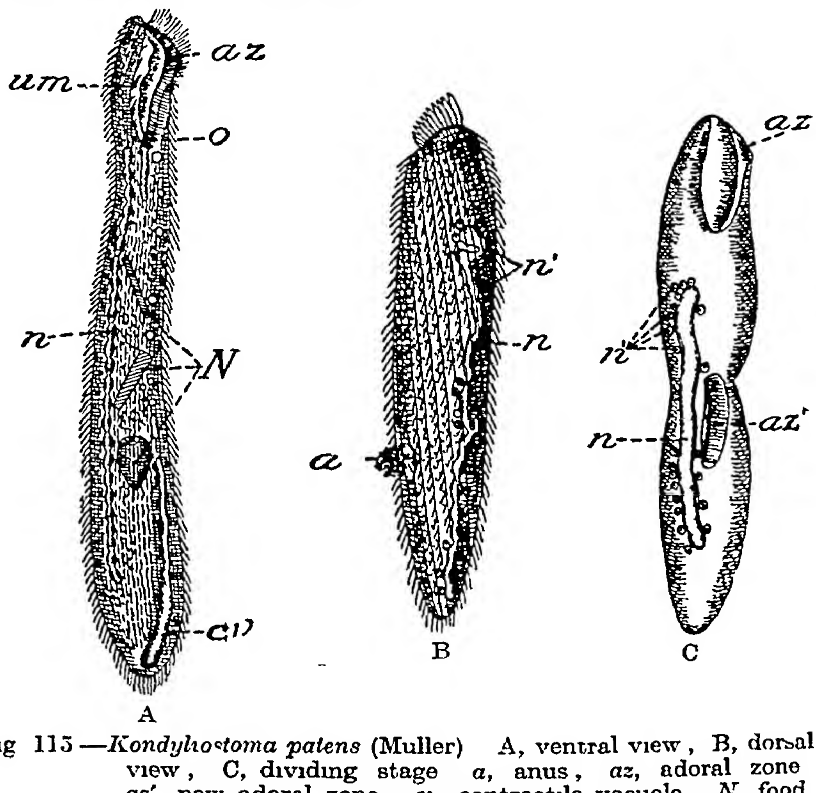


Fig 115 —*Kondylostoma patens* (Muller) A, ventral view, B, dorsal view, C, dividing stage *a*, anus, *az*, adoral zone *az'*, new adoral zone, *cv*, contractile vacuole, *N*, food particles *n*, macronucleus *n'*, micronuclei, *o* cytostome, *um*, undulating membrane (After Bütschli)

Dimensions —Length of extended body up to 500μ

Remarks —This species is usually referred to as marine, though it has been doubtfully recorded by Koch from garden soil (Sandon) Madhava Rao has given a very inadequate description, and mentions two nuclei (instead of one moniliform macronucleus) It is not certain that he correctly identified the form

Habitat —Soil MYSORE

4 Family STENTORIDÆ Claus, 1863

Body free or in a gelatinous test, with fine cilia Peristome at right angles to the long axis of the body or at a marked angle with it Peristomial surface uniformly ciliated No undulating membrane present Adoral zone completely encircles the broad peristomial field at the anterior end of the body, and runs in a spiral course down to the oral funnel

Key to Indian Genera

1 Peristome not occupying the whole of the anterior end	Climacostomum, [p 233
2 Peristome occupying the whole of the anterior end, directed at right angles to the long axis of the body	Stentorella, p 234

Genus **CLIMACOSTOMUM** Stein, 1859

Climacostomum Stein, 1859 *d*, pp 55, 72, 78, 81, 83, 84, 86, 88, 95, 1867, p 208, Butschli 1887–9, p 1727, Hickson, 1903, p 406, Calkins, 1926, pp 107, 408, Lepsi, 1926 *a*, p 66, Schoenichen, 1927, p 222, Kahl 1927, p 191, 1930–5, p 459

Medium-sized Body oval, persistent in form, about twice as long as broad, obliquely truncated anteriorly Peristome short, harp-shaped, occupying the anterior third of the ventral side Cytopharynx long, bent Vacuole with two radiating canals Macronucleus central and oval, or long, band-shaped and entwined

136 **Climacostomum virens** (Ehrenberg) Stein (Fig 116)

Bursaria spirigera, Ehrenberg, 1833, pp 234, 252
Spirostomum virens, Ehrenberg, 1838, p 332, pl xxxvi fig 1, *1–3*
Bursaria spirigera, Dujardin, 1841, p 511
Climacostomum virens, Stein, 1859 *d*, pp 55, 60, 64, 72, 78, 81, 83, 84, 86, 88, 95, 1867, pp 210–15, pl iv, figs 2–9
†*Spirostoma virens* (?), Carter, 1856 *b*, p 248, pl vii, fig 84
Leucophrys patula, Kent, 1880–2, p 587, pl xxix, fig 18
Leucophrys curvilata, Stokes, 1886
Climacostomum virens, Butschli, 1887–9, pl lxviii fig 4, Penard, 1922, p 208, fig 204, Lepsi, 1926 *a*, p 71, fig 322, Schoenichen, 1927, p 222, pl xii, fig 53, Kahl, 1927 *a*, pp 191–2, fig 36, 1930–5, pp 459–60, figs 76, *1–2*

Body sac-like, somewhat pointed in front and rounded behind Dorsal surface convex, ventral flat or slightly depressed Ciliary lines longitudinal, with fine cilia Peristome large, occupying one-fourth to one-third of the body, with a well-developed adoral band along its right border No undulating membrane Cytopharynx very long, bent behind,

and provided along both margins with short, fine cilia Cytoplasm coloured green by zoochlorellæ Contractile vacuole very large, terminal, provided with two radiating canals,

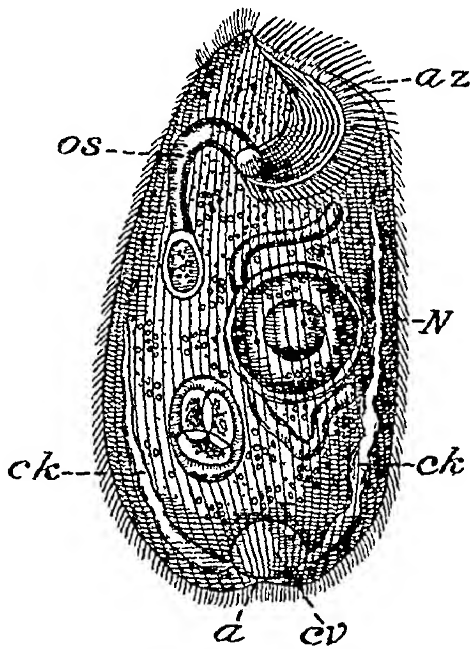


Fig 116 —*Climacostomum virens* (Ehrbg) *a*, anus, *az*, adoral zone, *ck*, radiating canals, *cv*, contractile vacuole, *N*, macro nucleus, *os*, cytopharynx (After Bütschli)

which run forwards Macronucleus elongated, band-shaped and twisted

Dimensions —Length 150–300 μ

Habitat —Fresh water BOMBAY, Bombay

Genus STENTORELLA Reichenbach, 1828

(=STENTOR Oken, 1815, nom preoccupied for a genus of Mammalia, E Geoffrey, 1812)

Stentor, Oken, 1815, p 45
Stentorella, Reichenbach, 1828, p 95
Stentor, Ehrenberg, 1838, p 261, Dujardin, 1841, p 520, Claparède & Lachmann, 1858–61, p 222, Stein, 1867, p 220, Fromentel, 1874, p 153, Kent, 1880–2, p 588, Bütschli, 1887–9, p 1727, Roux, 1901, p 84, Hickson, 1903, pp 405, 406, Minchin, 1912, pp 439, 441, 445, 446, Calkins, 1926, p 407, Wenyon, 1926, pp 41, 61, Lepsi, 1926 *a*, p 64, Schoenichen, 1927, p 222, Knowles, 1928, p 523, Reichenow, 1929, p 1188, Kahl, 1930–5, p 461

Animalcules fixed or free-swimming at will, in the former

case attaching themselves by their softer adherent posterior extremity, which may develop weak pseudopodia for this purpose, to submerged aquatic objects and sometimes secreting a jelly-like sheath or lorica Very large, colourless, or blue, red, brown or green in colour Body highly elastic and variable in form, when swimming and contracted, purse-shaped or spherical, when fixed and expanded, trumpet-shaped, broadly expanded anteriorly, tapering off and attenuate towards the attached posterior extremity Cilia of the cuticular surface very fine, distributed in even longitudinal rows, occasionally supplemented by sparingly scattered hair-like bristles The peristome takes up the whole of the anterior end of the body, and its margin shows a right-handed spiral of more than one full turn, and courses with the adoral cilia to the deepest part, where the cytostome lies followed by a tubular cytopharynx Peristomial cilia cirrose, very large and strong Anal aperture close behind the peristome on the left side The contractile vacuole also on the left side, near the peristomial border with two radiating canals, one of them extending backwards along the left side of the body, and the other coursing along the peristomial border Macronucleus rounded, elongate and band-shaped or moniliform, micronuclei numerous Locomotion in swimming stage moderately quick and revolving Feeds on infusoria, flagellates, unicellular algæ and organic debris Reproduction by transverse fission Inhabiting fresh and salt water, mostly social

137 **Stentorella polymorphus** (O F Muller) Ehrenberg (Fig 117)

Vorticella polymorpha, Müller, 1773, p 98, 1786, p 260, pl xxxv, figs 1–13
Stentor polymorphus, Ehrenberg, 1831, pp 43, 99, 152 pl iii, fig 3, 1833, p 182, pl iv, fig 1 *a–e* 1838, p 263, pl xxiv, fig 1, *1–5*
Stentor mulleri, Ehrenberg, 1831, p 99, 1833, p 183, pl v, fig 1 *a–e*, 1835, p 165, pl i, fig xvi 1838, p 262, pl xxiii, fig 1, *1, 3, 4*
Stentor polymorphus, Dujardin, 1841, p 523, pl xv, fig 2
Stentor mülleri, Dujardin, 1841, p 522
Stentor vert, Dujardin, 1841, p 523, pl xv, fig 2
Stentor polymorphus, Claparède & Lachmann, 1858–61, p 225, Stein, 1859 *d*, pp 55, 60, 64, 72, 74, 78, 80, 86, 89, 90, 95, 1867, pp 228–39, pl v, figs 1–12, Pritchard 1861, p 583, pl xxix, fig 7, Fromentel, 1874, pp 253–4, pl i, figs 1–5, Kent, 1880–2, pp 590–1, pl xxx, figs 10–20, Roux, 1901 p 85, pl v, fig 6
†*Stentor polymorphus*, Ghosh, 1921 *a*, p 15, Bhatia, 1922, p 32
Stentor polymorpha, Calkins, 1926, p 145, fig 74
Stentor polymorphus, Lepsi, 1926 *a*, p 72, figs 329, 330, Schœmichen, 1927, p 222
†*Stentor polymorphus*, Bhatia and Mullick, 1930, p 401
Stentor polymorphus, Kahl, 1930–5, p 463, fig 76, *6*

Very large Body trumpet shaped, colourless or yellow, sometimes green on account of zoochlorellæ The expanded anterior end in the fully extended animal equalling in diameter one third of the body-length Contractile vacuole situated

Fig 117

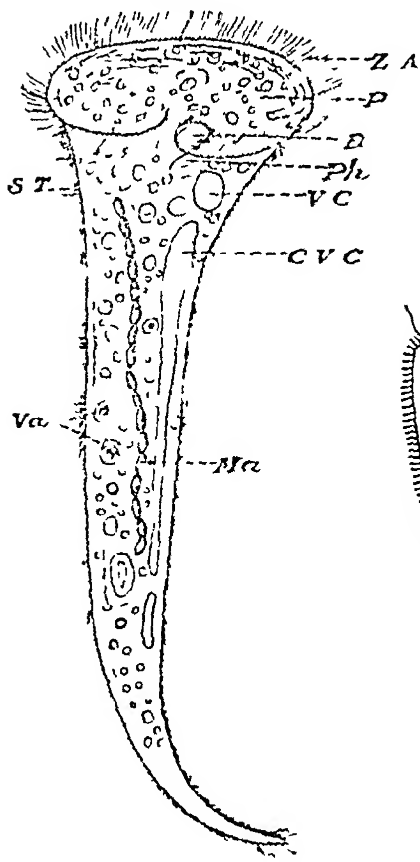


Fig 118

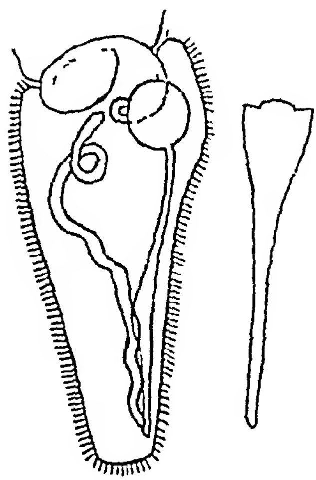


Fig 117—*Stentorella polymorphus* (Muller) *B* cytostome *C V C*, radiating canal *Ma* macronucleus, *P* peristome *Ph* cytopharynx, *S T* tactile bristles, *Va*, food vacuoles *V C*, contractile vacuole, *Z A*, adoral zone (After Roux)

Fig 118 —*Stentorella viridis* Ghosh (After Ghosh)

near the mouth, with a backwardly directed canal Macro nucleus moniliform, consisting of rounded or oval beads Solitary or social

Dimensions—Length when fully extended up to 1250 μ, in contraction 200 μ or more

Remarks—The specimens met with at Lahore have always belonged to the colourless variety (*Stentor mulleri* of Ehrenberg), and have been seen both singly and in the social condition The presence of a moniliform nucleus, the absence of a gelatinous lorica, and of the hair-like bristles along the margins of the body or the circlet of finer setæ at the posterior extremity enables the form to be referred to *S polymorphus* It is less rounded anteriorly than *S cœruleus*

The specimens found at Srinagar were solitary, usually full of disc-shaped zoochlorellæ and appeared to be green, others were less full and appeared colourless Body was metabolic, and when the organism was disturbed it contracted to form a small globule then gradually expanded swimming for some time in a half expanded condition The peristomial field in a fully expanded organism was circular in outline, and the disc was raised in the centre The adoral cilia were very long and strong The peristomial margin was spirally coiled at its left extremity and formed a depression, at the bottom of which was the cytostome The general surface of the body was covered with very fine cilia distributed along close set parallel lines No stronger bristles were present on the body

The specimens found by Ghosh at Calcutta were social, and were generally attached to submerged water-plants

Habitat—Standing water among vegetation KASHMIR, Srinagar, PUNJAB, Lahore BENGAL, Calcutta

138 **Stentorella viridis** Ghosh (Fig 118)

†*Stentor viridis*, Ghosh, 1921 *a*, p 15, fig 9
Stentor rœseli, Kahl, 1930–5, p 464, fig 76, *10, 12, 17, 20, 23, 24*

Body elongately conical with a truncate apical end when fully expanded, ovoid to pyriform when contracted Colour, yellow Peristomial margin not expanded, and slightly less in width than the greatest width of the body Pseudostome raised cushion-wise Peristomial notch shallow Longitudinal ciliary striæ distinct Cilia over the general surface of the body fine and uniform, those at the truncate aboral end long and stout Contractile vacuole irregularly spherical, placed immediately beneath the pseudostome, with a canal extending to the aboral pole and presenting a fusiform dilatation Macronucleus ribbon-shaped, much coiled, and extending through the entire length of the body

Dimensions—Length 250–300μ Width 75–80μ Diameter of pseudostome 43μ

Remarks—The animalcules are found in pond water amongst *Vorticella* and *Epistylis* colonies They are never social The species resembles *S rœseli* and *S barretti* in

the form of its macronucleus, but differs from them in its smaller size, and the absence of bristles and a gelatinous sheath Kahl (1930-5) doubts the specific identity of the form and regards *S barretti* Kent, *S gracilis* Maskell, and *S viridis* Ghosh as synonyms of *S rœseli* Ehrbg

Habitat —Pond-water, among *Vorticella* and *Epistylis* colonies BENGAL Calcutta

139 **Stentorella** sp

†*Stentor* sp Carter, 1856 *b*, p 119

Habitat —Fresh water Bombay

5 Family FOLLICULINIDÆ Dons, 1912

Marine forms, living in pseudochitinous tests Peristome drawn out into two wings, with the adoral zone continued along the margin of both Peristomial surface ciliated No undulating membrane present

Genus **FOLLICULINA** Lamarck, 1816

Folliculina, Lamarck, 1815-16, ii, p 29
? *Folliculina* part, emend Bory, 1824
Freia, Claparede & Lachmann, 1852-61, p 217, Stein, 1867, p 272, Fromentel, 1874, p 150
Folliculina, Kent, 1880-2, p 596, Butschli, 1887-9, p 1728, Hickson, 1903 p 407, Dons, 1912, pp 73-93, Penard, 1919, pp 305-19, pls i, ii, Calkins, 1926, p 407, Lepsi 1926 *a* p 64, Reichenow, 1929, p 1189, Kahl, 1930-5, p 469

Body highly elastic and contractile, secreting a horny sheath or lorica, to which it remains fixed by its posterior extremity Peristome occupying the whole of the anterior extremity, prolonged into two elongate and usually symmetrical, flattened, lappet-like lobes, the cleft between which is deepest on the ventral side, peristomial fringe originating on the ventral side at the base of the right-hand lobe, skirting the entire margin of the bilobate frontal border, descending in a shortly revolute spiral manner into the oral aperture on arriving at the base of the left-hand lobe Peristomial or adoral cilia very long, those of the general cuticular surface exceedingly fine, disposed in even longidudinal rows Anal aperture situated close to the base of the left-hand peristomial lobe Contractile vacuole central or absent Macronucleus oval, central, or elongated and moniliform Mostly inhabiting salt water

140. Folliculina ampulla (O F Muller) Lamarck (Fig 119)

Vorticella ampulla O F Muller 1786, pp 283–5, pl xl, figs 4–7
Folliculina ampulla, Lamarck 1815–16, ii p 30
Freia ampulla, Claparède & Lachmann, 1858–61, pp 221–2, pl ix, figs 6, 7
Freia aculeata, Claparède & Lachmann 1858–61, p 221, pl x, figs 5, 6, 8
Folliculina ampulla, Stein, 1867, pp 275–89, pls x, xi, Kent, 1880–2, pp 597–8, pl xxix figs 21–28, Butschli, 1887–9, pl lxix fig 3
†*Folliculina ampulla*, Annandale, 1907 pp 37, 143
Folliculina ampulla Dons, 1912 p 81 Sahrhage, 1916, pp 139–74, pls x, xi, Lepsi 1926 *a*, p 73, figs 338–40, Calkins, 1926, p 160, fig 84 B, Reichenow, 1929, p 1189, fig 1172 Kahl, 1930–5, p 470, fig 77, *5*, *5 a*

Very large Body lodged in a sheath or lorica, which is deep blue-green or sea-green, flask-shaped, attached laterally, with the neck bent upwards Neck short in young individuals, but becoming much prolonged with age and usually ornamented

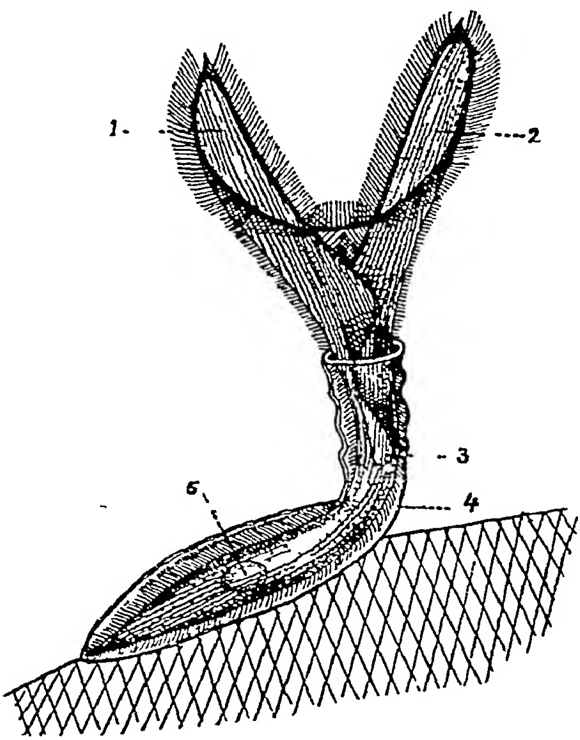


Fig 119 —*Folliculina ampulla* (O F Mull) 1, 2, wing-like outgrowths on which the adoral zone is extended, 3, cytostome at the bottom of the peristomial funnel, 4, flask-shaped test in which the animal can withdraw itself, 5, macronucleus (From Reichenow after Stein)

with either horizontal or spirally ascending annulations or with longitudinal flutings, margin of aperture even, circular Animalcules similar in colour to the sheath Peristome reaches deep in the anterior part of the neck, and bears two similar wing like lobes, which are from three to six times as long as broad and bluntly or sharply pointed at their end, and which bear an adoral zone of membranelles Cytostome at the bottom of the peristomial funnel Macronucleus spherical Length of the lorica up to 1000 μ Marine

Remarks—Annandale noted the occurrence of *F ampulla* without mentioning the name of the author of the species According to Kahl (1930–5) *F ampulla* (O F Mull), *F mœbiusi* Kahl (=*Frei ampulla* Mobius, *F ampulla* Sahrhage), *F* (*Freia*) *aculeata* (Cl & L) (=*ampulla* St partim), and *F boltoni* Kent (=*F ampulla* Cl & L, *F simplex* Dons, *Ascobius lentus* Henneg) are distinct species

Habitat—Brackish water pond LOWER BENGAL, Port Canning In close association with the hydroid stage of *Irene ceylonensis* (=*Campanulina ceylonensis*)

6 Family BURSARIDÆ Perty, emend Kahl

Body finely ciliated Peristome forming a sac-like depression of the anterior end, which is provided with a ventral slit Adoral zone runs in this depression and is continued into the bent oral funnel Peristomial surface is not ciliated

Genus **BURSARIA** O F Muller, 1773

Bursaria, O F Muller, 1773, p 62, part, Ehrenberg, 1838, p 325, part, Dujardin, 1841, p 508, emend Claparède & Lachmann, 1858–61, p 251, Stein, 1867, p 297, Kent, 1880–2, p 575, Schuberg, 1886, p 335, Butschli, 1887–9, p 1726, Roux, 1901, p 82, Hickson, 1903, pp 405, 406, Minchin, 1912, p 439, Penard, 1922, pp 205–8, Lepsi, 1926 *a*, p 65, Calkins, 1926, p 408, Schoenichen, 1927, p 220, Kahl, 1927 *a*, p 198, 1930–5, pp 476–9, Reichenow, 1929, p 1190

Animalcules free swimming, very large, colourless or brownish, form constant, flexible, when moderately extended purse shaped, ventral surface somewhat flattened Anterior extremity broadly truncate, posterior extremity broad, rounded or somewhat pointed The chief feature is the great and characteristic development of the peristomial field Peristome is wide, funnel-shaped, and extends to even further back than the middle of the body, the posterior tube like

narrower portion of the peristome usually bends over to the left, enclosed in the peristome is an elongated and very narrow mouth-cleft, running almost the whole length of the peristome along the right side An adoral zone, consisting of very broad membranelles, extends on the left side along the whole length of the peristome, but does not extend over its anterior border Anal aperture postero-terminal Contractile vacuoles usually absent, but sometimes many distributed all over the body Macronucleus long, band-shaped, and meandering, micronuclei numerous Cysts spherical with a double coat Inhabiting fresh water

Remarks—Writers prior to Stein, and Claparède and Lachmann included in the genus *Bursaria* a large number of widely diverse forms, now distributed, with one or two exceptions, among the genera *Plagiotoma*, *Nyctotherus*, *Leucophrys*, *Ophryoglena*, *Balantidium*, *Paramecium*, and *Opalina* Out of a score of species associated with the title *Bursaria* by Ehrenberg, only one, *Bursaria truncatella* Müller, is now left to represent the genus

141 **Bursaria truncatella** O F Muller (Fig 120)

Bursaria truncatella, O F Muller, 1773, p 62, 1786, p 115, pl xvii, figs 1–4, Ehrenberg, 1831, p 110, 1838, p 326, pl xxxiv, fig v, 1, 2
Bursaria vorticella, Ehrenberg, 1838, p 326, pl xxxiv, fig vi 1–3
Bursaria decora, Claparède & Lachmann, 1858–61, p 252, pl xiii, fig 1
Bursaria truncatella, Stein, 1859 *d*, pp 78, 81, 95, 100, 1867 pp 300–9, Kent, 1880–2, p 576, pl xxix, figs 1 & 2, Schuberg, 1886, pp 333–65, pls xix, xx, Butschli, 1887–9, p 1726, pl lxvii fig 6, pl lxviii, fig 1, Roux, 1901, p 83, pl v, fig 4, Hickson, 1903, p 407, figs 59, 60
†*Bursaria truncatella*, Bhatia, 1922, p 30
Bursaria truncatella, Penard, 1922, pp 205–8, fig 203, Lepsi, 1926 *a*, p 71, fig 318, Calkins, 1926 p 160, fig 84 A, Schoenichen, 1927, p 220, pl xii, fig 52, Kahl, 1927, pp 198–9, fig 40, 1930–5, pp 476–9, fig 78, *1–4*, Reichenow, 1929, p 1190, fig 1173

Body broadly ovate, purse or sac-shaped, the ventral surface flattened, the dorsal convex, scarcely one and a half times as long as broad, widest posteriorly, narrowed slightly at the truncate anterior extremity, the frontal angles rounded The margin of the right side convex, usually longer than that of the left, the margin of the shorter left side slightly concave Contractile vacuoles many, distributed all over the body Macronucleus long, band-like, and meandering, micronuclei numerous Pond and marsh water Feeds on diatoms and organic debris, etc Movements swift with rotation on the longitudinal axis

Dimensions.—Length up to 1.5 mm.

Remarks.—As observed by Kent, the species is apparently by no means cosmopolitan, but when present usually occurs in considerable abundance. Specimens were found in considerable numbers at Lahore, and were of a large size, easily visible to the naked eye and opalescent white in appearance, creeping about slowly. Various authorities, Butschli (1889), Hickson (1903), Lang (1913), Doflein (1916), seem to differ in their interpretation of the same figure which they reproduce from Schuberg. Bhatia (1922) has fully discussed these differences of interpretation.

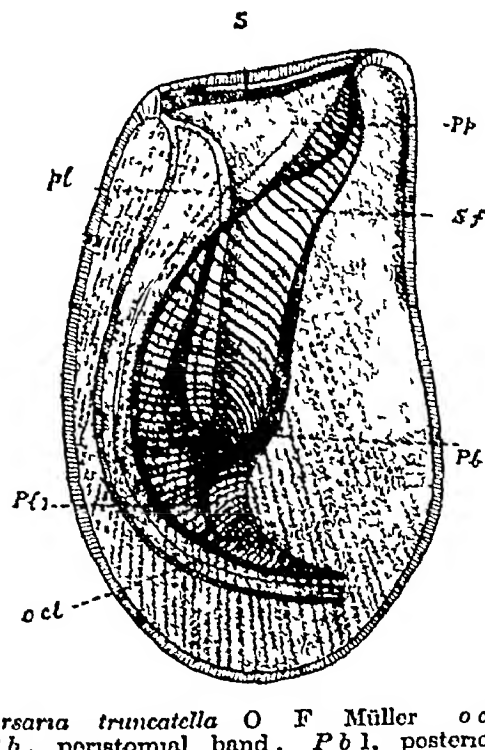


Fig. 120.—*Bursaria truncatella* O. F. Müller. *o cl*, oral cleft, *P b*, peristomial band, *P b 1*, posterior prolongation of the peristomial band, *Pp*, peristomial depression, *P pl*, peristomial plate, *S*, sphincter myophan band, *Sf*, peristomial striations. (After Schuberg.)

Although there is a posterior tube-like continuation of the peristome, it seems best to say that there is no gullet, as, properly speaking, there is no cytopharynx following a definite cytostome, the gutter-like cleft serving the purpose of a mouth opening. Kahl (1927), contrary to the opinion of all other observers, states that he is unable to find an oral cleft, but that in pressed animals there is a cleft-like folding of the neighbouring plate

Again, Butschli writes "Ciliation moderate, the peristomial field unciliated Undulating membrane wanting" Lang (1913, fig 155, *10*) indicates a "peristomplatte," which is finely ciliate along the free edge, while Hickson (1903, fig 59), referring to the peristomial cavity, says " a thin vertical fold projects into this cavity on the right side (left in the figure) and a thicker striated fold projects into it on the left side" In my specimens I was not able to make out this vertical fold on the right side, though there was a distinct flap along the left of the peristomial field, and this flap bore fine cilia along its free edge in the prominent anterior portion only The cavity of the peristome is the entire area enclosed between the two cross-striated lines curving backwards from the anterior margin of the body and not merely the space enclosed between the so-called peristomial bands represented dark in the figure as here reproduced (fig 120)

Habitat—Pond water PUNJAB, Lahore

INCERTÆ SEDIS

Genus **PARABURSARIA** Ghosh, 1921

Parabursaria, Ghosh, 1921 *a*, p 12

Agrees with *Balantidium* in having a cup shaped peristome at the anterior end, but is said to differ from it in having an adoral zone of cilia outside the peristome (*sic*) It differs from *Bursaria* Muller and *Bursaridium* Lauterborn in having no cytopharynx, and from the latter in having no membranelles and in the presence of the adoral zone of cilia

Remarks—In my opinion the genus is not sufficiently characterized and the species is inadequately observed and described I do not consider the genus as a valid one, but have quoted the description from the original author for convenience of reference

142 **Parabursaria pheretima** Ghosh (Fig 121)

†*Parabursaria pheretima*, Ghosh, 1921 *a*, pp 12–13, fig 10

Body irregularly spherical, with an annular constriction in the middle and a rounded prominence on one side of the anterior portion Peristome cup-shaped, occupying the truncate anterior end No cytopharynx Posterior end rounded Minute cilia arranged closely in longitudinal rows An adoral zone of long cilia extending from the left side of the peristome backwards beyond the middle of the body and then nearly horizontally from left to right round the body, for about one-third its circumference Contractile vacuole single, subcentral

Measurements not stated

Habitat—In the seminal vesicles of *Pheretima posthuma* (L Vaill) BENGAL, Calcutta

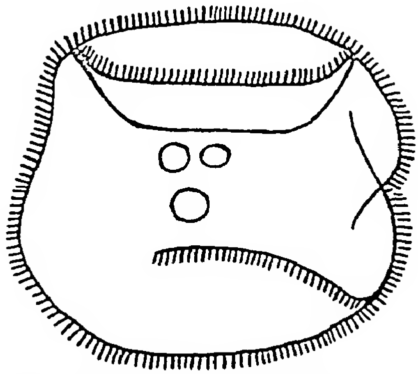


Fig 121 —*Parabursaria pheretima* Ghosh (After Ghosh)

7. Family BALANTIDIIDÆ Reichenow, 1929

Body finely ciliated Peristome forms a cleft, broader anteriorly and extending from the anterior pole of the body more or less backwards towards the ventral surface Dorsal wall of the peristome provided with an adoral row of long cilia. Peristomial surface not ciliated Cytostome situated at the bottom of the peristome and may be followed by a distinct cytopharynx Endoparasitic

Genus **BALANTIDIUM** Claparède & Lachmann, 1858, emend Stein

Bursaria, part, Ehrenberg, 1838, p 325
Leucophrys, part, Stein, 1859 *d*, pp 72, 80, 88, 95
Plagiostoma, part, Claparède & Lachmann, 1858–61, p 241
Balantidium, Claparède & Lachmann, 1858–61, p 247, Stein, 1867, p 309, Fromentel, 1874, p 186, Kent, 1880–2, p 577, Butschli, 1887–9 p 1724
Balantidopsis, Butschli, 1887–9, p 1725
Balantidium, Hickson, 1903, pp 405, 406 Bezzenberger, 1904, p 157, Minchin, 1912, pp 439, 440, Hegner & Taliaferro, 1924, pp 387, 415–33, Calkins, 1926, p 408, Wenyon, 1926 p 1201 Bhatia & Gulati, 1927 p 102, Knowles, 1928, p 527, Abé, 1928–9, p 89, Reichenow 1929, p 1190, Thomson & Robertson, 1929, pp 268–74, Kudo, 1931, p 374
Balantidiopsis, Kudo, 1931, p 374
Balantidium, Hegner, 1934, pp 38–67

Body ovate or pear-shaped, completely covered by spirally-arranged parallel rows of cilia Anterior end slightly truncate; peristome straight, somewhat triangular, widest

anteriorly, beginning at the anterior end of the body, and with its narrow posterior end on the ventral surface. Cytostome situated in the depression of the peristome and followed by a cytopharynx which ends blindly in the endoplasm. An adoral row of long cilia commences at the posterior end of the peristome, passes along the right margin of the peristome, across its anterior margin, and then backwards along the left margin to a point near where it started; it then passes into the cytostome, and is continued backwards in the same spiral manner till it reaches half-way down the cytopharynx, where it ends. Contractile vacuoles one or many. Anal aperture postero-terminal. Macronucleus sausage-shaped or spherical, with a small micronucleus closely applied to it. Multiplication by transverse fission; conjugation has been repeatedly observed in *B. coli*. Transmission to other hosts through formation of spherical cysts. Occurring as parasites within the intestinal viscera of many vertebrate and invertebrate hosts.

Remarks.—Bhatia and Gulati (1927) have reviewed the literature on this genus. *Bursaria entozoon* of Ehrenberg was made the type of the genus *Balantidium* by Claparède and Lachmann. Butschli established a new genus, *Balantidiopsis*, for *B. duodeni*. The genus *Balantidiopsis* is distinguished as broadly egg-shaped, flattened, with spherical macronucleus and a single contractile vacuole at the posterior end. Schaudinn amalgamated the two again. Schweier, apparently without knowledge of Schaudinn's work, adhered to Butschli's arrangement of the species in two genera. Bezzenberger discussed the reasons for which the two genera cannot be recognized as distinct and re-grouped all the species under *Balantidium*. Abé (1928–9) has reclassified all the species of *Balantidium* and referred them to three genera, viz., *Balantidium*, *Balantidiopsis*, and *Protobalantidium*, the last being newly established by him and characterized by having an oval, egg-shaped, or elongated cylindrical body, circular or oval in section, with the peristome bearing membranelles, undulating membrane, or a row of cilia on its inne wall. I do not propose to follow this classification, and have grouped all the species under the generic title of *Balantidium*.

Up to 1933 thirty-two species, together with some doubtful ones, had been described as belonging to this genus. Of these two are from Cœlentrates, and of these one is also found in Annelids; one from a Turbellarian, six from Arthropods, two from Molluscs, two from Fishes, twelve from Amphibia, one from a Reptile, and six from Mammals. Hegner in 1934 reviewed the data on which specificity is based in this genus and described six new species. Three of these are from monkeys, one from the camel, one from the opossum, and one from the ostrich.

*Key to Indian Species**

1 (17)	Peristome not reaching the middle of the body	2
2 (12)	Body round in transverse section	3–11
3	Contractile vacuole 1 Macronucleus spherical Body irregularly pyriform Length 90 μ	*B blattarum* Ghosh, [p 249
4	Contractile vacuole 1 or more Macronucleus kidney shaped Body elongated egg shaped, 76–130 μ by 50–70 μ	*B helenæ* Bezz , p 259
5	Contractile vacuoles 2 Macronucleus oval Body cylindrical Transverse diameter throughout similar Length to breadth as 10 1 up to 6 1 130–360 μ by 25–36 μ	*B gracile* Bezz , p 258
6	Body cylindrical Transverse diameter wider near hinder end Length 2½ to 3 times the width 90–142 μ by 33–62 μ (Stein and Bhatia & Gulati) According to Kent, length equals 208–292 μ	*B elongatum* Stein, [p 256
7	Body egg shaped, broader, 30–200 μ by 20–70 μ	*B coli* (Malmsten), [p 249
8	Body egg shaped, greatest width in the middle, 60–120 μ by 44–90 μ Macronucleus ribbon like with folded ends	*B coli* var *bovis*, [Cooper & Gulati, [p 253
9	Contractile vacuoles 3 Macronucleus broadly oval Body torpedo shaped, with axial and peripheral fibres in the peristomical area, 150–319 μ by 35–65 μ	*B sushilii* Ray, [p 264
10	Body large, oval Peristome wide, cylindrical, obliquely directed Macronucleus oval	*B testudinis* Chagas [p 266
11	Contractile vacuoles 4 Macronucleus oval or kidney shaped Body egg-shaped, 205 μ by 133 μ	*B giganteum* Bezz [p 257
12 (2)	Body oval in transverse section	13–16
13	Contractile vacuole 1, subcentral Macronucleus oval Body oval with a deep concavity on the ventral surface, 50–63 μ by 37 μ	*B depressum* (Ghosh), [p 253
14	Contractile vacuole 1 Macronucleus broadly oval Body ovate Length 85 μ	*B ovatum* Ghosh, [p 261
15	Contractile vacuole 1 Macronucleus oval Body almond shaped, 50 by 35 μ	*B amygdalli* Bhatia & [Gulati, p 247
16	Contractile vacuole 1 Macronucleus circular and disc like Body ovate, 10–11 μ by 5 μ	*B rhesum* Ghosh, [p 262
17 (1)	Peristome reaching the middle of the body or further	18

* A key to all the species of the genus known up to 1926, and the list of hosts are given in Bhatia & Gulati (1927)

18 (23) Body flattened 19–22

19 Contractile vacuole 0 Macronucleus oval Body egg shaped, anterior end broader, 40–50 μ by 29–40 μ Peristome showing two depressions or bays *B bicavata* Bhatia & [Gulati, p 248

20 Contractile vacuole 1 Macronucleus round or oval Body ovate, with a granular area in the anterior half Length 41–62 μ (Stein), 74–115 μ (Bhatia & Gulati), 86–130 μ (Kent) Width 37–52 μ (Stein), 53–71 μ (Bhatia & Gulati) Dobell gives 75 μ by 56 μ for his form *B duodeni* Stein, [p 254

21 Contractile vacuole 1 Macronucleus oval Body round or broadly egg-shaped, 56 μ by 44 μ Peristome slit-like *B rotundum* Bezz , [p 263

22 Contractile vacuole 1 Macronucleus rounded or broadly oval Body ovate, 40 μ by 25 μ Peristome large, ovate *B knowlesii* Ghosh, [p 260

23 (18) Body rounded in transverse section 24

24 Contractile vacuoles 2 Macronucleus oval Body oval, anteriorly tapering to a blunt point, 65 μ by 40 μ *B rhinarum* Ghosh, [p 262

143 Balantidium amygdalli Bhatia & Gulati (Fig 122)

†*Balantidium amygdalli*, Bhatia & Gulati, 1927, p 110, fig 11
Protobalantidium (?) *amygdalli*, Abe, 1928–9, p 89
Balantidium amygdalli, Hegner, 1934, p 49, fig 46

Body almond-shaped, narrow anteriorly and broadest behind the middle Length of the body one and a half times the width Peristome very small, extending a very short distance from the anterior end and narrowing posteriorly

Fig 122

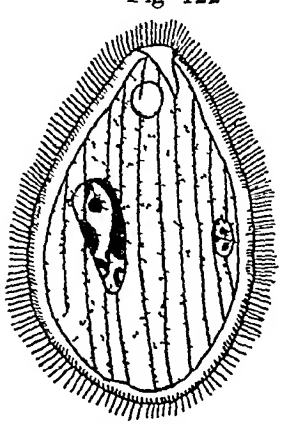


Fig 123

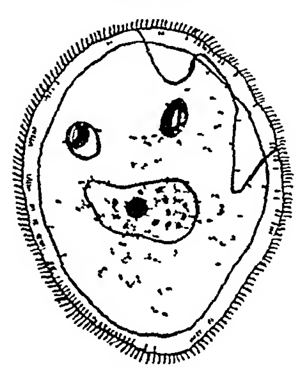


Fig 122 —*Balantidium amygdalli* Bh & G (After Bhatia & Gulati)
Fig 123 —*Balantidium bicavata* Bh & G (After Bhatia & Gulati)

Contractile vacuole anterior Macronucleus ellipsoidal Micro nucleus rounded or somewhat oval

Dimensions —Length 50μ, maximum width 35μ

Remarks —The cytoplasm is granular and the ectoplasm clearly marked off from the endoplasm Cilia are fine and close set and are disposed in longitudinal rows on the surface of the body Just internal to the basal granules is a layer of trichocysts The contractile vacuole is placed close to the peristome The macronucleus contains several large deeply staining chromatin masses in its interior The micronucleus shows fine chromatin particles in it

The form somewhat resembles *B ovatum* Ghosh, described from the cockroach, *Periplaneta americana*, in the shape of the body, but differs from it in the shape of the macronucleus, which is oval and not spherical, and in the contractile vacuole being situated anteriorly It further differs from that species in the absence of the canal leading from the contractile vacuole, which is characteristic of that species

Habitat —Rectum of *Bufo macrotis* Bouleng PUNJAB, Sialkot

144 **Balantidium bicavata** Bhatia & Gulati (Fig 123)

†*Balantidium bicavata*, Bhatia & Gulati, 1927 p 109, fig 10
Protobalantidium (?) *bicavata*, Abe, 1928–9, p 89
Balantidium bicavata, Hegner, 1934 p 48, fig 47

Body oval in form, anterior end broadly rounded, posterior end somewhat narrower, with the greatest width in the anterior half of the body, from one and a quarter to one and a half times as long as wide Peristomial field excavate in front, and, instead of running as a single furrow or groove, shows two depressions or bays on the ventral surface, extending up to the middle of the body Contractile vacuole absent Macronucleus oval Micronucleus oval

Dimensions —Length 40–50μ, maximum width 29–40μ

Remarks —The cytoplasm has a granular appearance There is no marked differentiation between cortex and medulla The cilia are fine and close set and are disposed in oblique longitudinal rows Trichocysts are present and form a distinct row just beneath the outer layer The macronucleus contains a dark centrally placed chromatin mass and other irregularly scattered chromatin particles The micronucleus is placed in the anterior half of the body

This species differs from the others in the form of the body, the character of the peristome, and the form and structure of the macronucleus

Habitat —Rectum of *Bufo melanostictus* Schneid PUNJAB, Lahore

145 Balantidium blattarum Ghosh (Fig 124)

†*Balantidium blattarum*, Ghosh, 1922 *a*, pp 15–16, fig 1, Bhatia & Gulati, 1927, p 111
Balantidium blattarum, Hegner, 1934, p 49, fig 39

Body irregularly pyriform, slightly less than twice as long as its greatest transverse diameter, and circular in transverse section Anterior end tapering and rounded, posterior end obliquely truncate Body cilia small and closely arranged Peristome small, about one-third the body in length, somewhat cylindrical and directed backwards and medianwise A large undulating membrane along the anterior margin of the peristome, and a row of stout cilia along its posterior margin Endoplasm coarsely granular and surrounded by a distinct

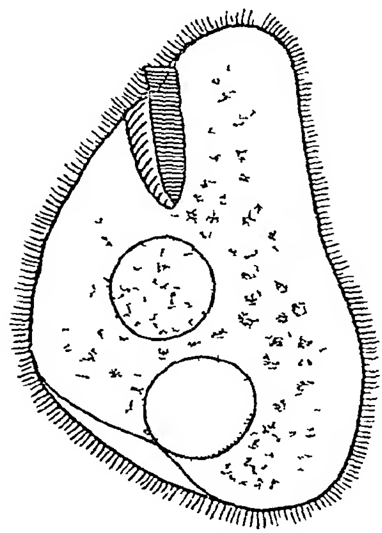


Fig 124 —*Balantidium blattarum* Ghosh (After Ghosh)

hyaline ectoplasm Contractile vacuole large, posterior Macronucleus spherical, central

Dimensions —Length 90 μ

Habitat —Intestine of *Periplaneta americana* PUNJAB, Lahore, BENGAL, Calcutta

146 Balantidium coli (Malmsten) (Fig 125)

Paramæcium (?) *coli*, Malmsten, 1857, pp 302–9, figs 1–6
Plagiostoma coli, Claparède & Lachmann, 1858–61, pp 241–3, pl xi, fig 10
Leucophrya coli, Stein, 1860 *b*, p 47
Paramæcium (?) *coli*, Leuckart, 1861, pp 80–6, pl v, figs A, B, 1863, pp 146–51 fig 21

Balantidium coli, Stein, 1867, pp 320–5, pl xiv, figs 10, 14–18 Kent, 1880–2, p 578, pl xxix, figs 16, 17, Mitter, 1891, pp 1–41 1 pl, Noc 1908, pp 878–80, Brumpt, 1909, pp 103–5, Minchin 1912, p 440, Walker 1913, pp 333–49, 7 pls
†*Balantidium coli* Castellani & Chalmers 1919, pp 247–8, fig 200
Balantidium coli, Dobell & O'Connor, 1921, p 107, pl vii, fig 100 McDonald, 1922, pp 243–300, pls xxvii, xxviii
†*Balantidium coli*, Sinton, 1923, p 432
Balantidium coli, Hegner & Holmes, 1923, pp 252–63, pls v, vi, Hegner & Taliaferro, 1924, pp 416–27, figs 161, 162 *a* 163, 164, Lepsi, 1926 *a* p 70, fig 309 Wenyon, 1926 pp 1201–1210, Noller, 1926, pp 89, 90, figs 28, 29, *1–3*, Craig, 1926, pp 518–23, figs 89, 90
†*Balantidium coli*, Knowles, 1928, pp 527–530, figs 133, 134, Chatterjee, 1928, p 79
Balantidium coli, Reichenow, 1929, pp 1192–4, figs 1174–6, Thomson & Robertson, 1929, pp 268–73, figs 173, 175–8 181 Kudo, 1931, p 374, fig 161, *b*, *c*, Hegner, 1934 pp 41–6, figs 1 4, 14, 17

Body egg-shaped, slightly broader at the posterior end, narrowed and pointed at the anterior end Cilia over the entire body arranged in longitudinal rows with a slightly spiral course Peristome on the ventral surface, at the anterior end, placed somewhat obliquely, varying in its appearance with the constant changes in the shape of the anterior end of the body from a wide open depression to a longitudinal groove or slit Adoral zone of cilia passes round the peristome and through the cytostome into the cytopharynx Cytostome can be closed by a very mobile non-ciliated oral plug Cytopharynx short Ectoplasm clear McDonald (1922) has described in association with the cyto stome and adoral cilia a neuro motor system of fibres and a co ordinating centre or motorium, which is embedded in the ectoplasm near the cytopharynx Endoplasm varying with the state of nutrition Sometimes with numerous vacuoles, each of which contains a highly refractile globule, at other times the vacuoles contain red blood corpuscles, leucocytes, or other debris Contractile vacuoles two, one at the posterior end and the other near the middle of the body Anal aperture present at the posterior end of the body Macronucleus sausage-shaped or bean-shaped, lying more or less transversely at the middle of the body, with a small micronucleus close to it Reproduction by transverse fission preceded by division of the two nuclei Repeated and rapid binary fissions lead to the formation of "nests" of parasites in the tissues of the host Cysts of two types have been reported Two Ciliates become attached to one another by their peristomes and enclosed in a cyst Exact details of conjugation within the cyst not known More frequently, single individuals become encysted

Dimensions —Size from 30 to 200μ or more in length and from 20 to 70μ in breadth The usual range is 50–70μ long

by 40–60μ wide Cysts measure 50–60μ in length, and slightly less in breadth

Remarks —*B coli* is widely distributed throughout the world, and has been recorded from man, monkeys, and pigs In human beings infection is most common in individuals who come into association with pigs, and it is believed that the Ciliate is a common parasite of the pig and occasionally infects man and monkeys A second widely different species, *B suis*, also occurs in the pigs, but is not known to infect man

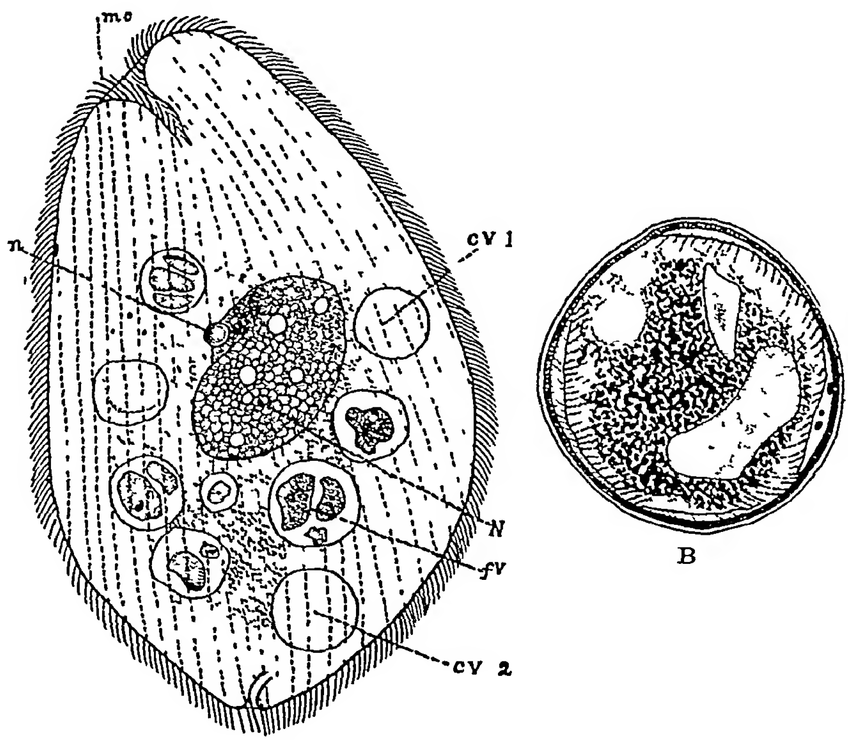


Fig 125 —A *Balantidium coli* (Malm) *c v* 1, anterior contractile vacuole, *c v* 2, posterior contractile vacuole, *f v* food vacuole, *mo*, peristome leading to the mouth, *N*, macro nucleus, *n*, micronucleus B Encysted form (After Dobell & O'Connor)

Wenyon (1926) has given an excellent summary of all that is known about this species The supposed pathogenicity, pathology, experimental work to test the susceptibility of different animals, and the action of various drugs are all fully discussed in his work Hegner (1934) has summed up the present position of the species occurring in man, chimpanzee and pig

Records from India are scanty Sinton (1923) recorded a symptomless infection with *B coli* in a Pathan prisoner in the Lahore jail Ramsay informed Knowles that infection is not uncommon in the Cachar tea-gardnes Shanks also informed him of a fatal case of balantidial dysentery that occurred at the Calcutta Medical College, and Knowles himself observed a case of infection As remarked by Knowles (1927), " Balantidium infection is usually symptomless and is present in the ' carrier state,' and only occasionally does it give rise to dysentery When dysentery does set in, however, it is apt to be very severe, extensive necrosis and sloughing of the mucous membrane of the colon takes place and mortality rates are apt to be high "

Cultivation —Prowazek (1913) kept *B coli* from man alive for seven days by mixing physiological saline with fæces Barret and Yarbrough (1921) used a mixture of 0 5 per cent sodium chloride solution and inactivated human serum in the proportion of 16 1, and were able successfully to cultivate the Ciliate for thirty-eight days, during which time eleven transplants were made In 1923 Van der Reis attempted to cultivate *Balantidia* from man, using a medium composed of 5 0 per cent meat bouillon and 0 5 per cent saline combined with human blood serum in the proportion of 10 1 or 15 1 He had no success until he added 24-hour cultures of *Bacillus fecalis alkaligenes* to his culture of *Balantidium*, but by this addition he was able to maintain the culture for thirty-two days Rees (1927) and Jameson (1927) were both successful in cultivating *Balantidium* from the pig for some time Rees employed Ringer's solution in place of 0 5 per cent saline used by Barret and Yarbrough, combining it with either horse or human blood-serum, or Loeffler's dehydrated blood-serum in the proportion of 9 1 He also found that the addition of sterile rice starch to this medium aided materially in the cultivation of *Balantidium* Jameson cultivated the organism for about three months, using a modification of the medium devised for the cultivation of intestinal amœbæ, a slant of coagulated horse-serum covered with Ringer's solution, with or without egg-white He also found addition of rice starch essential for the cultivation of this Ciliate Schumaker (1931 *a*) has also cultivated *B coli* successfully, using the technique of Rees and of Jameson He used for each tube 10 c c of a medium consisting of 1 c c of sterile horse-serum and 9 c c of sterile Ringer's solution of the formula —NaCl, 6 50 g , KCl, 0 14 g , $CaCl_2$, 0 12 g , $NaHCO_3$, 0 20 g , NaH_2PO_4, 0 01 g , distilled water 1000 c c He, too, found the addition of sterile rice starch essential

Habitat —Human stools PUNJAB, Lahore, BENGAL, Calcutta, ASSAM, Cachar, CEYLON

147 **Balantidium coli var bovis** Cooper & Gulati (Fig 126)

†*Balantidium coli*, var *bovis* Cooper & Gulati, 1926 pp 192-3 pl xi
Balantidium coli var *bovis*, Hegner, 1934, p 49, fig 33

Body egg-shaped, narrower, and tapering anteriorly, broad and rounded posteriorly Length and breadth in the ratio of 4 3 Greatest width in the middle of the body Body covered with fine, small, and close-set cilia, arranged in longitudinal parallel rows Adoral cilia distinctly longer Peristome short and funnel-like, situated near the anterior pole, but not quite terminal, inclined towards the median plane

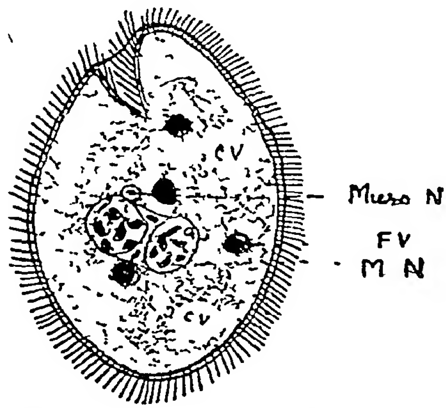


Fig 126 —*Balantidium coli* v *bovis* C & G *c v* contractile vacuole, *F V* food-vacuole, *M N*, macronucleus, *Micro N* micronucleus (After Cooper & Gulati)

Contractile vacuoles two Macronucleus a ribbon-like structure folded at each end, appearing oval or bean-shaped in a darkly stained specimen, in which case the folds at the two ends cannot be seen Micronucleus adjacent

Dimensions —Length 60–120 μ, breadth 44–90 μ

Remarks —This variety differs from *B coli* from man in that the greatest width of the organism is in the middle of the body, and the macronucleus is ribbon-shaped with folded ends

Habitat —Intestine of cattle ASSAM

148 **Balantidium depressum** (Ghosh) (Fig 127)

†*Balantidiopsis depressum* Ghosh, 1921 *a*, p 13, fig 12
Balantidium depressum Bhatia & Gulati, 1927, p 104
Protobalantidium depressum Abe, 1928-9, p 89

Body simply or elongately oval, slightly narrowed, and rounded anteriorly, wide and tapering to a point posteriorly ,

oval in transverse section A deep concavity on the ventral surface, occupying the posterior third of the body Longitudinal ciliary striæ distinct and close to one another Peristome small and fusiform, about one-fifth of the body-length and directed obliquely backwards A row of longer cilia placed along its left margin Contractile vacuole posterior and lateral Macronucleus oval and central Micronucleus spherical and placed at the side of the macronucleus

Dimensions —Length 50–63 μ, breadth 37 μ

Remarks —Dr H N Ray, who has re-examined the form, informs me in a personal communication that Ghosh's de scription of the species is wrong in certain respects According to him the body is slightly pointed at either end, is circular in transverse section, both the lateral margins are symmetrical, and there is no concavity on the ventral surface The macronucleus is bean-shaped and variable in position Micro nucleus is oval or spindle-shaped and usually lies in the notch of the macronucleus He further adds that both axial and peripheral systems of fibres are present, and a boring apparatus is situated at the anterior extremity of the axial system of fibres on the left side of the peristome

Habitat —Rectum of *Pila* (*Ampullaria*) *globosa* (Swainson) BENGAL, Calcutta

149 **Balantidium duodeni** Stein (Fig 128)

Balantidium duodeni, Stein, 1867, pp 325–6, pl xiv, figs 19–23, Kent, 1880–2, p 578
Balantidiopsis duodeni, Butschli, 1887–9, p 1725, pl lxviii, fig 3
Balantidium duodeni, Bezzenberger, 1904, p 157
†*Balantidium hyalinum*, Dobell, 1910, p 75, fig 19
Balantidium duodeni, Lepsi, 1926*a*, p 70, figs 311, 312, Wenyon, 1926, p 1210, Noller, 1926, p 90
†*Balantidium duodeni*, Bhatia & Gulati, 1927, pp 105–6, fig 7
Balantidium duodeni, Reichenow, 1929, p 1191
Balantidiopsis duodeni, Kudo, 1931, p 375, fig 161, *d*
Balantidium duodeni, Hegner, 1934, p 49, fig 42

Body ovate, flattened, length from only slightly more than the width up to one and a half times Peristome narrow, cleft-like, and reaching to the middle of the body Contractile vacuole single, posterior Macronucleus oval or kidney-shaped Micronucleus close behind Cysts spherical

Dimensions —Length 74–115 μ (Stein and Kent, 86–130 μ), breadth 53–68 μ (Stein, 77–109 μ)

Remarks —Dobell (1910) described a species, *B hyalinum*, from the duodenum of *R tigrina* in Ceylon, and stated that his form did not differ markedly from other duodenal forms, viz, *B duodeni* Stein and *B rotundum* Bezz, but the protoplasm was stated to be more hyaline In the anterior region there is a striated or granular triangular area, which is also

characteristic of *B duodeni* and *B rotundum* As in these forms, the cilia are long and well developed over the whole body The average dimensions are *ca* 74μ by 56μ, which fall well within the dimensions as recorded by Stein or Kent for *B duodeni*, or as found by Bhatia and Gulati for their specimens of *B duodeni* On carefully comparing Dobell's figure of *B hyalinum* with those of *B duodeni* in the works of Stein and other authors, the two are seen to be almost identical The only difference appears to be that the macronucleus is placed more posteriorly in the body and the micronucleus shown near the anterior end of the macronucleus I do not consider *B hyalinum* as specifically distinct from *B duodeni*

Fig 127

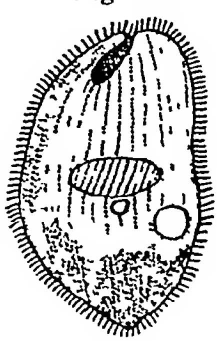


Fig 128

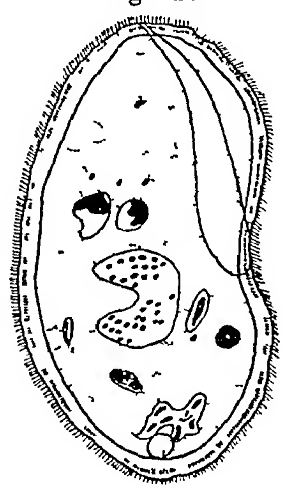


Fig 127 —*Balantidium depressum* (Ghosh) (After Ghosh)
Fig 128 —*Balantidium duodeni* St (After Bhatia & Gulati)

In the form met with at Lahore the body is flat and oval, anteriorly narrower, with the greatest width near the posterior end The length of the body is one and a half times the width The peristomial field is excavate, nearly straight or bent a little at its posterior end, and reaches the middle of the body The peristome is not followed by a cytopharynx The cytoplasm is not clearly differentiated into cortical and medullary regions and has a dense granular appearance The anterior region shows a striated triangular area

Habitat —Duodenum and small intestine of *Rana tigrina* Daud PUNJAB, Lahore , CEYLON

150 **Balantidium elongatum** Stein (Fig 129)

Balantidium elongatum, Stein, 1867, pp 319–20, pl xiv, figs 11–13, Kent, 1880–2, p 577 Bezzenberger, 1904, p 157, Lepsi 1926*a*, p 70, fig 308, Noller, 1926, p 90
†*Balantidium elongatum*, Bhatia & Gulati, 1927, pp 107–8 fig 8
Protobalantidium elongatum, Abe, 1928–9, p 89
Balantidium elongatum, Reichenow, 1929, p 1191, Jirovec 1930 p 20, fig 2, Hegner, 1934 p 49, fig 38

Body elongate, cylindrical, from two to three times as long as broad, anterior end pointed or more or less rounded, posterior end drawn out Peristome long, triangular, extending up to about one-fourth of the length of the body Contractile vacuoles two, median and posterior Macronucleus oval or kidney-shaped Micronucleus adjacent

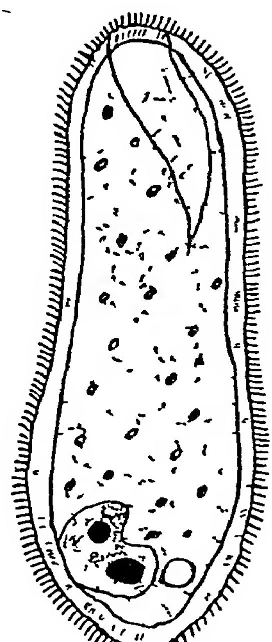


Fig 129 —*Balantidium elongatum* St (After Bhatia & Gulati)

Dimensions —208–297 μ by 69–130 μ (Stein), 90–124 μ by 39–53 μ (Bhatia and Gulati), 215 μ by 63 5 μ (Jirovec)

Remarks —In the specimens examined at Lahore, the length of the body is two and a quarter to three times the width, and the greatest width is behind the middle of the body The cytoplasm is not clearly marked into cortical and medullary regions, and the medullary region has a dense granular appearance Cilia are of uniform length, fine and close set, and arranged in longitudinal rows The anus is situated near

the posterior end of the body The posterior contractile vacuole lies a little in front of the anus, and at the moment of its contraction is seen to be connected by a canal with the anal opening The macronucleus is oval in outline, sometimes notched, and is situated near the posterior end or in the posterior half of the body The micronucleus lies close to the macronucleus These specimens measured only 90–124μ by 39–53μ The size of the species thus appears to vary a good deal

Habitat —Intestine of *Rana tigrina* Daud , PUNJAB, Lahore

151 **Balantidium giganteum** Bezzenberger (Fig 130)

†*Balantidium giganteum*, Bezzenberger, 1904, pp 148, 150–1, figs 9, 10

Balantidium giganteum, Noller, 1926, p 90, Bhatia & Gulati, 1927, p 111, Hegner, 1934, p 59, fig 52

Body regularly egg-shaped, round in transverse section Body surface covered with short cilia arranged in distinct

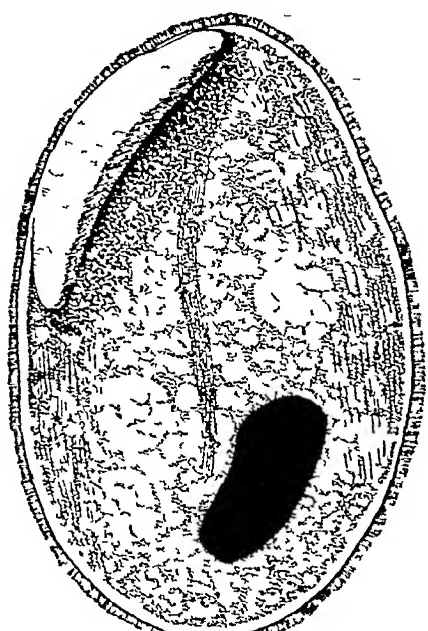


Fig 130 —*Balantidium giganteum* Bezz (After Bezzenberger)

rows Peristome is a moderately large, broad and deep pocket and does not extend to the middle of the body, the left lip carries membranelles which do not cover the whole width

of the peristomial field Contractile vacuoles four Macronucleus is kidney-shaped or oval, the micronucelus lies in the notch if the macronucleus is kidney-shaped, or near one end if the latter is oval

Dimensions —Length 205μ, width 133μ

Habitat —Cloaca of *Rana esculenta* var *chinensis* Osb ASIA (exact locality not cited by Bezzenberger)

152 Balantidium gracile Bezzenberger (Fig 131)

†*Balantidium gracile*, Bezzenberger, 1904, pp 152–3, pl xi, figs 2–3
Balantidium gracile, Noller, 1926, p 90
†*Balantidium gracile*, Bhatia & Gulati, 1927, pp 108–9, fig 9
Protobalantidium gracile, Abé, 1928–9, p 89
†*Balantidium gracile*, de Mello, 1932, p 109, pl xiii, figs 7, 8
Balantidium gracilis, Hegner, 1934, p 59, fig 50

Body cylindrical, tapering, and rounded at both ends, six to twelve times as long as wide Peristome excavate,

Fig 131

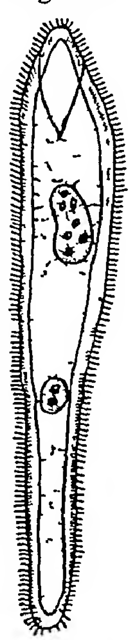


Fig 132

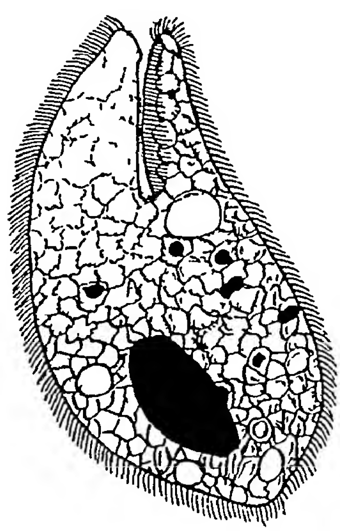


Fig 131 —*Balantidium gracile* Bezz (After Bhatia & Gulati)
Fig 132 —*Balantidium helenæ* Bezz (After de Mello)

extending up to about one-seventh of the length of the body Contractile vacuoles two Macronucleus oval Micronucleus rounded

Dimensions —Length 132–210μ, width 25–36μ (Bezzenberger gives 360μ by 30μ), de Mello gives minimum length

75μ, maximum length 175μ, most commonly 94–112μ in length and 18–30μ in width

Remarks —The body is round in transverse section, and the transverse diameter is practically the same throughout the whole length In the somewhat contracted condition the body is seen to be curved in an elegant manner The peristome is short and bottle-shaped, and bears long and abundant cilia along one of its borders The cytoplasm is alveolar and clearly defined into cortical and medullary regions, the latter being loose and very clear round the nucleus, and also contains mitochondria The two contractile vacuoles lie in the anterior part of the body The macronucleus is oval and granular, and lies mostly in the posterior half or in the middle, rarely in the anterior half The micronucleus is rounded and placed in a depression of the posterior part of the macronucleus, or sometimes at some distance from the macronucleus

Habitat —Rectum of *Rana cyanophlyctis* Schn and *R hexadactyla* Lesson ASIA (exact locality not cited by Bezzenberger), rectum of *R hexadactyyla* Lesson PUNJAB, Lahore, small intestine of *R tigrina* Daud NOVA GOA

153 **Balantidium helenæ** Bezzenberger (Fig 132)

†*Balantidium helenæ*, Bezzenberger, 1904, pp 151–2, pl xi, fig 1
†*Balantidium ovale*, Dobell, 1910, p 74
Balantidium helenæ, Noller, 1926, p 90.
Balantidium ovale, Noller, 1926, p 90
†*Balantidium helenæ* Bhatia & Gulati, 1927, p 106, de Mello, 1932, pp 105–8, pl xiii, figs 1–3, 6, pp 117, 119
Balantidium helenæ, Hegner, 1934, p 49, fig 37

Body ovoid, anterior pole narrow, posterior wider, length of the body only a little more than the width Peristome excavated, not reaching up to the middle Contractile vacuole single or variable number irregularly distributed in the body Macronucleus kidney-shaped, with a rounded micronucleus lying in its notch

Dimensions —Minimum 45 by 30μ, maximum 175 by 62μ, usually between 75–125μ in length Macronucleus 31–37μ in length, 10–18μ in width, on an average 29 2μ by 14 6μ Micronucleus 5μ by 2 5μ Width between ciliary lines 3 5μ

Remarks —In the forms examined at Lahore the body is broadly oval with the posterior end projecting like a knob The length of the body is only a little more than the width The cytoplasm is clearly defined into cortical and medullary portions The cortical portion appears to be structureless, but the medullary portion is densely granular Cilia arise from definite elongated granules lying within the pellicle

Bezzenberger gives the dimensions as 110–130 μ in length and 60–70 μ in width The specimens examined at Lahore measured *ca* 76 μ in length and 52 μ in width, and were thus considerably smaller

Dobell (1910) described from the same host in Ceylon a form which he named *B ovale* It differs from *B helenæ* Bezz only in size The average size of his forms was about 80 μ by 50 μ Bhatia and Gulati (1927) consider this form as belonging to the same species as *B helenæ* De Mello (1932) encountered in the same host forms that were oval like *B ovale* Dobell, and forms that were elongated like *B helenæ* Bezz The former measured 36–90 μ in length and 28–66 μ in width, or on an average 55–70 μ by 45–50 μ, the latter measured 45–100 μ in length and 30–65 μ in width, or on an average 60 μ by 45 μ From a detailed study he found that the structure of the two forms is identical, and the position of the nucleus, as also the occurrence of numerous transitional forms, leads him to accept the opinion expressed by Bhatia and Gulati that the two species are one and the same

Habitat—Rectum of *Rana tigrina* Daud ASIA (exact locality not cited by Bezzenberger), rectum of *R tigrina* Daud PUNJAB, Lahore, CEYLON Intestine of *R tigrina* Daud, *R cyanophlyctis* Schn, and *R limnocharis* Wiegm NOVA GOA

154 **Balantidium knowlesii** Ghosh (Fig 133)

†*Balantidium knowlesii*, Ghosh, 1925, p 189, fig 1
Balantidium knowlesii, Wenyon, 1926, p 1211
Balantidium sp, Knowles, 1928, p 533
Protobalantidium knowlesii, Abe, 1928–9, p 89
Leptoglena knowlesii, Grasse & Boissezon, 1929, p 191
Balantidium knowlesii, Hegner, 1934, p 49, fig 45

Body broadly ovate, wider posteriorly than anteriorly, slightly less than twice as long as wide Anterior end narrow

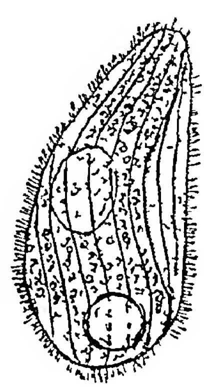


Fig 133—*Balantidium knowlesii* Ghosh (After Ghosh)

and tapering, posterior end rounded Dorsal surface convex, more prominent posteriorly and with several faint longitudinal grooves Ventral surface flattened Peristome large, cup-like, ovate in shape and occupying the ventral surface, leaving a narrow space all round except on the right lateral margin Adoral row of cilia not well developed No distinct undulating membrane Body completely ciliated, anterior body cilia long Ectoplasm thin Endoplasm coarsely granular Contractile vacuole, single, posterior Macronucleus rounded or broadly oval, placed in the middle of the body Micronucleus single, lodged in a depression of the macronucleus

Dimensions —Length 40μ, greatest width 25μ

Remarks —The species resembles *B rotundum* in having a large wide peristome, but differs from that species in (i) the peristome occupies nearly the entire ventral surface, (ii) the macronucleus is spherical and central, and (iii) the contractile vacuole is posterior

Habitat —In the cœlomic cavity of *Culicoides peregrinus* BENGAL, Calcutta

155 **Balantidium ovatum** Ghosh (Fig 134)

†*Balantidium ovatum* Ghosh, 1922 *b*, p 371, fig 1
Balantidium ovatum, Wenyon, 1926, p 1211, Bhatia & Gulati, 1927, p 111
Protobalantidium ovatum, Abe 1928–9, p 89
Balantidium ovatum, Hegner, 1934, p 49, fig 48

Body elongately oval, wider posteriorly than anteriorly, slightly less than twice as long as its greatest diameter and broadly oval in transverse section Anterior end rounded, posterior end abruptly tapering to a point Body cilia long, a row of longer and stouter cilia at the anterior end Peristome small, tubuliform, about one-fifth the length of the body, directed backwards and mesially There is an undulating membrane running along the postero-lateral portion of the peristome, and a row of stouter cilia in its anterior portion, continuous with the long anterior body cilia Ectoplasm thin, except near the anterior and posterior ends of the body Endoplasm densely filled with coarse granules Contractile vacuole large, posterior, with an anal canal opening in front of the posterior end Macronucleus broadly oval, situated in the middle of the body

Dimensions —Length 85μ

Remarks —This species is said to differ from all other known species of the genus in possessing an anal canal in connection with the contractile vacuole It is distinguished from *B blattarum* by its shape, the position of the undulating membrane, and in the thinness of the ectoplasm, but as the

description is based on a single specimen, Wenyon thinks it doubtful whether these two species, *B blattarum* and *B ovatum*, are specifically distinct

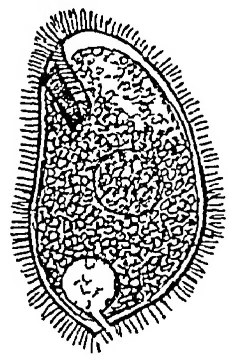


Fig 134 —*Balantidium ovatum* Ghosh (After Ghosh)

Habitat —Intestine of *Periplaneta americana* BENGAL, Calcutta

156 **Balantidium ranarum** Ghosh

†*Balantidium ranarum*, Ghosh, 1921 *a*, p 14
Balantidium ranarum, Bhatia & Gulati, 1927, p 112

Body elongately to broadly oval, tapering to a blunt point anteriorly and obliquely truncate or rounded at the posterior end Body more or less rounded in transverse section, sometimes with a slight depression posteriorly on one side Peristome extending from the anterior end to beyond the middle of the body, and provided with a distinct adoral row of long and stout cilia Body cilia long and uniformly arranged in meridional rows Contractile vacuoles two and postero-lateral, one on each side Macronucleus oval and variable in position, mostly in the middle and on one side, sometimes more anterior or posterior Micronucleus adjacent

Dimensions —Length 65μ, breadth 40μ

Habitat —Rectum of *Rana tigrina* Daud BENGAL, Calcutta

157 **Balantidium rhesum** Ghosh (Fig 135)

†*Balantidium* sp Knowles, 1928, p 533
†*Balantidium rhesum*, Ghosh, 1929 *a*, p 14, fig 1

Body ovate, nearly or less than twice as long as broad, anteriorly tapering and blunt, posteriorly broad and rounded Body oval in transverse section Peristome triangular, placed in front and somewhat laterally, and extending to one-fourth

the length of the body Contractile vacuole single, postero-terminal Macronucleus circular and disc-like with convex side, placed about the middle to one side, and containing a chromatin mass in the centre

Dimensions —Length 10–11 μ, breadth 5 μ

Remarks —The measurements as given by Ghosh are length 0 01–0 117 mm, breadth 0 0054–0 00525 mm Hegner (1934) is of the opinion that his measurements are obviously

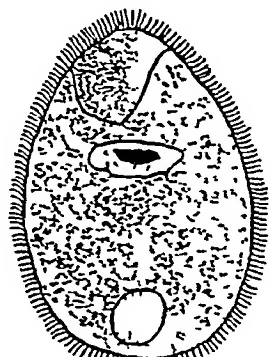


Fig 135 —*Balantidium rhesum* Ghosh (After Ghosh)

incorrect, and his description and illustration (as reproduced above) are so inadequate that this species (?) cannot be considered seriously He is further of the opinion that *B simile* Cunha & Muniz, 1930, from Rhesus monkeys imported into Brazil, is a valid species, and is characterized by a thickened cortical layer at the anterior end but as this character is not shown by Ghosh, this form cannot be identified with *B simile* without further investigation

Habitat —Intestine of *Macacus rhesus* BENGAL, Calcutta

158 **Balantidium rotundum** Bezzenberger (Fig 136)

†*Balantidium rotundum*, Bezzenberger, 1904, pp 153–4, pl xi, fig 4

Balantidium rotundum, Noller, 1926, p 90, Bhatia & Gulati, 1927, p 112, Hegner, 1934, p 59, fig 53

Body round or compactly egg-shaped, strongly compressed dorso-ventrally, with a marked bulging on the ventral surface in contrast to the plane dorsal surface Cilia extraordinarily long and fine Peristome slit-like, beginning near the anterior pole of the body and extending backwards along the right margin, but stopping short in front of the middle of the body, the left peristomial margin carries long and thick adoral cilia

Contractile vacuole single, lying in the right lower quadrant of the body Macronucleus is oval or slightly kidney-shaped, never spherical, and lies close to the margin in the left lower quadrant of the body Micronucleus is distinct and lies in the notch if the macronucleus is kidney-shaped, and in the middle or near one end if the latter is oval

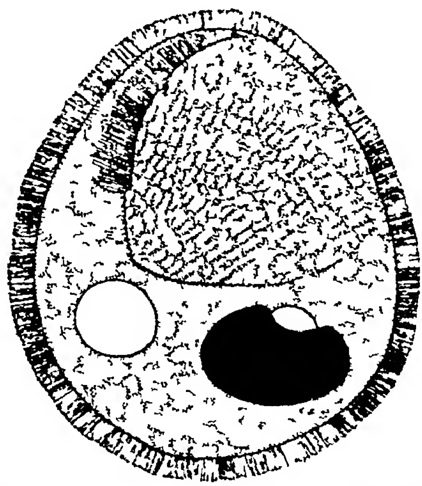


Fig 136 —*Balantidium rotundum* Bezz (After Bezzenberger)

Dimensions —Length 56μ, width 44μ

Habitat —Small intestine of *Rana esculenta* Linn var *chinensis* Osb ASIA (exact locality not cited by Bezzenberger)

159 Balantidium sushilii Ray (Fig 137)

†*Balantidium sushilii*, Ray, 1932, pp 374–82, figs 1–5 & 1 pl , Chakravarti, 1933, pp 345–6, figs 1–3
Balantidium sushilii, Hegner, 1934, pp 58–60, fig 49

Body torpedo-shaped, circular in transverse section Peristome begins as a narrow groove, gradually widening as it passes backwards, not reaching the middle of the body Left peristomial wall carries long cilia, the left peristomial lip bears an undulating membrane Morphonemes arranged in two conspicuous arches at the anterior end A boring apparatus present Contractile vacuoles three, two lateral and one terminal Macronucleus broadly oval, and very variable in position Micronucleus lateral to the macronucleus

Dimensions —Length 150–319 44μ, width 35–65μ

Remarks —Ray has described a system of axial and peripheral fibres in the peristomial area Placed slightly towards the left of the peristome and embedded in the cytoplasm are three or four fibres which are either parallel or twisted after

the manner of a rope They originate from just below the pellicle at the anterior end and extend posteriorly to a short distance behind the mouth A clear knob-like structure or " borer " is attached at the anterior termination of these fibres by means of a short neck The axial fibres together with the borer constitute the boring apparatus The borer has been found embedded in the intestinal epithelium of the host and serves to puncture the gut-wall The peripheral system of fibres, arranged in two conspicuous arches along the

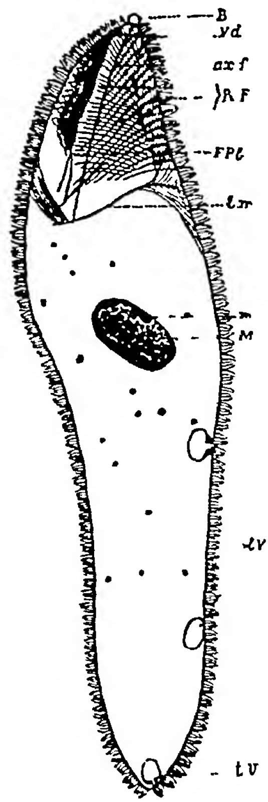


Fig 137 —*Balantidium sushilii* Ray *ax f*, axial system of fibres, *B*, borer, *F P b*, fibres attached to post peristomial border, *l m*, limiting membrane, *l V*, lateral vacuoles, *M*, macronucleus, *m*, micronucleus, *Pr F*, peripheral system of fibres, *t v*, terminal vacuole, *V d*, V shaped depression (After Ray)

left anterior border, is considered as serving the purpose of maintaining the rigidity of the peristomial area, and are therefore termed " morphonemes "

Habitat—Intestine of *Rana tigrina* Daud BENGAL, Calcutta

160 **Balantudium testudinis** Chagas (Fig 138)

Balantidium testudinis, Chagas, 1911, pp 142–3, pl x, figs 13–18
†*Balantidium testudinis*, Alexeieff, 1912, p 98
Balantidium testudinis, Wenyon, 1926, p 1211, Noller, 1926, p 90

Body large, oval in form Cytostome situated at the anterior end, leading into a wide, more or less cylindrical and obliquely directed cleft Cilia arranged regularly over the surface of the body, with longer cilia in the neighbourhood

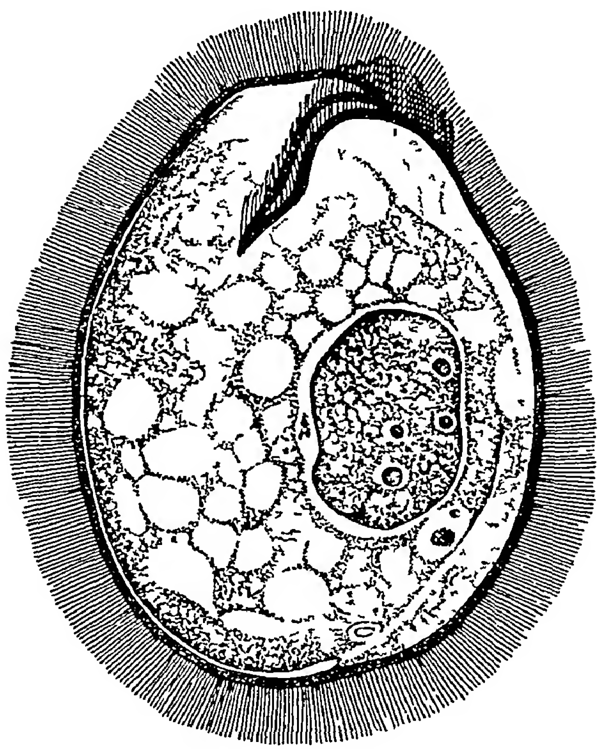


Fig 138 —*Balantidium testudinis* Chagas (After Chagas)

of the cytostome Endoplasm alveolar, with many inclusions Macronucleus oval, granular, central, with a number of karyosomes Micronucleus lying in a depression on the macronucleus Dimensions not recorded

Habitat —In the large intestine of *Geoemyda trijuga* CEYLON.

II. Suborder *OLIGOTRICHA* Butschli

Body cilia greatly reduced, only a few cilia or stiff bristles being present, or completely absent Adoral zone forms a nearly complete or quite complete ring around the margin of the peristome, which is usually at right angles to the long axis of the body The aboral part of the zone serves chiefly for locomotion, while the weakly developed oral part is employed for food capture and for carrying it to the oral funnel The oral funnel lies within or outside the adoral ring Freshwater or marine

Identification Table of Families

1 (4)	Without lorica	2
2 (3)	Oral funnel situated on the ventral surface outside the adoral ring	[Lachm , p 267 **Halteriidæ** Clap &
3 (2)	Oral funnel situated within the complete adoral ring	[now **Strobilidiidæ** * Re che
4 (1)	With a gelatinous or pseudochitinous lorica, to the bottom of which the contractile posterior end is attached by an elongated stalk, oral funnel within the complete adoral ring	[Lachm p 269 **Tintinnidæ** Clap &

1. Family HALTERIIDÆ Claparède & Lachman, 1859, emend Kahl

Without a lorica Body covered with a few scattered bristles or none at all The oral funnel lies on the ventral surface outside the adoral ring Freshwater or marine

Genus **HALTERIA** Dujardin, 1841

Trichoda, part, Muller, 1773, p 71 , 1786, p 160
Trichodina, part, Ehrenberg, 1838, p 265
Halteria, Dujardin, 1841, p 414 , Claparède & Lachmann, 1858–61, p 368 , Stein, 1867, p 162 , Fromentel, 1874, p 158 , Kent, 1880–2, p 631 , Butschli, 1887–9, p 1732 , Roux, 1901, p 92 , Hickson, 1903, p 409 , Minchin, 1912, p 439 , Lepsi, 1926 *a*, p 75 , Calkins, 1926, p 409 , Sandon, 1927, p 191 , Schoenichen, 1927, p 225 , Reichenow, 1929, p 1195 , Kahl, 1930–5, p 504

Animalcules free-swimming, very small, more or less globose and constant in form Oral aperture terminal, eccentric, associated with a wreath of large cirrose cilia A zone of

long stiff springing bristles developed around the equatorial region of the body Locomotion restless, extremely violent, shooting or springing forwards, with momentary pauses during which the animal remains stationary

161 **Halteria grandinella (O F Muller)** (Fig 139)

Trichoda grandinella, O F Müller, 1773, p 77, 1786, p 160, pl xxiii, figs 1–3
Trichodina grandinella, Ehrenberg, 1838, p 267, pl xxiv, fig 5
Halteria grandinella, Dujardin, 1841, p 415 pl xvi, fig 1
Trichodina grandinella, Claparède & Lachmann, 1858–61, p 369, pl xiii, figs 8, 9
Halteria grandinella, Stein, 1867, p 162, Fromentel, 1874, p 262, pl xxiv, figs 1, 1 *a*, Kent, 1880–2, p 632, pl xxxii, figs 35–8, Butschli, 1887–9, p 1732, pl lxix, fig 6, Roux, 1901, p 93, pl v, fig 15
†*Halteria grandinella*, Bhatia, 1920, p 262
Halteria grandinella, Penard, 1922 pp 224–6, Faure Fremiet, 1923, pp 61–2, fig 20, Hegner & Taliaferro, 1924, pp 387–8, fig 146
†*Halteria grandinella*, Gulati, 1925, p 9, fig 21
Halteria grandinella, Lepsi, 1926 *a*, p 76, figs 361, 362, Sandon, 1927, p 191, pl vi, fig 9, Schoenichen, 1927, p 225, pl xiii, fig 2, Reichenow, 1929, p 1195, Kahl, 1930–5, p 504, fig 82, *1*

Body subglobose, transparent, terminating posteriorly in somewhat narrower obtusely rounded point Springing

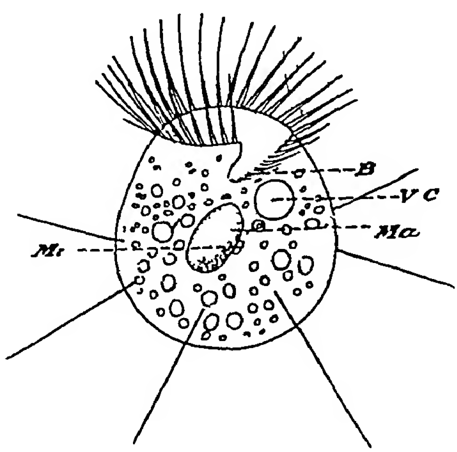


Fig 139—*Halteria grandinella* (O F Mull) *B*, cytostome, *Ma*, macronucleus, *Mi*, micronucleus, *V C*, contractile vacuole (After Roux)

bristles very long and fine, forming a central girdle, but not situated in an equatorial groove or furrow Macronucleus oval to kidney-shaped Contractile vacuole in the anterior half of the body Common in stagnant water of ponds

Dimensions —Length up to 40μ

Remarks —The specimens examined at Lahore were rounded and measured only 25μ in length The organism possessed comparatively few central bristles, and only a few (6 or 7) of the larger cilia at the anterior end

This species was originally included in the genus *Trichoda* O F Mull, but Dujardin (1841), recognizing the differences as regards the position of the mouth and the arrangement of the adoral ciliary wreath, made *Trichoda grandinella* O F Mull the type of the new genus *Halteria*

Habitat —Pond water PUNJAB, Lahore

162 **Halteria** sp

†*Halteria* sp, Chaudhuri, 1929, p 54, pl iii, fig 9

Habitat —Soils from N W FRONTIER PROVINCE, Peshawar, and CENTRAL INDIA, Indore

2 Family TINTINNIDÆ Claparède & Lachmann, 1858.

With a gelatinous or pseudochitinous lorica, to the bottom of which the contractile posterior end of the body is attached by an elongated stalk The oral funnel lies within the adoral zone, which forms a complete ring The family is rich in marine plankton forms, and includes only a few freshwater forms

Kofoid and Campbell (1929) raise the family to the status of a suborder, and divide it into a number of families Their work should be referred to for a monographic treatment of the group

Genus TINTINNOPSIS Stein, 1867

Tintinnus, part, Ehrenberg, 1840, Claparède & Lachmann, 1858–61, p 195

Tintinnopsis, Stein, 1867, pp 154, 168

Codonella, Hackel, 1873 *b*, v, vii, p 565

Tintinnopsis, Kent, 1880–2, p 617, Butschli, 1887–9, p 1735 Hakson, 1903, p 409 Calkins, 1926, p 409, Lepsi, 1926 *a*, p 75, Kahl, 1930–5, p 516

Body campanulate or pyriform, attached posteriorly by a slender retractile pedicle within a membranous cylindrical lorica without a neck-like portion, lorica wall single, simple, with numerous adherent sand-grains or other foreign particles Peristomial cilia forming two complete and independent

ciliary circlets, those of the outer series flexible and tentaculi form, those of the inner short and cirrose General surface of the body traversed longitudinally from one end to the other by rows of short cilia, between which intervene bare interspaces of considerable extent

Marine or freshwater

163 **Tintinnopsis lacustris** (Entz sen) (Fig 140)

Codonella lacustris, Entz sen , 1885, pp 196–200, pl xiii, figs 10–16
†*Codonella lacustris*, Daday, 1898, p 8
Tintinnopsis lacustris forma *lævis*, Entz jun , 1909 *b*, p 207, pl iv, fig 2 , Fauré Fremiet, 1923, pp 87–90, fig 28
Codonella lacustris, Lepsi, 1926 *a*, p 79, fig 385
Codonella cratera, Kahl, 1930–5, p 517, fig 82, *25*, *42*, *43*

Body cylindroid, nearly truncated anteriorly by the edge of the peristomial lip, acuminated posteriorly, and with a short pedicle Lorica cylindrical, with a round base, rigid, and encrusted with foreign particles or clearly arenaceous In freshwater plankton

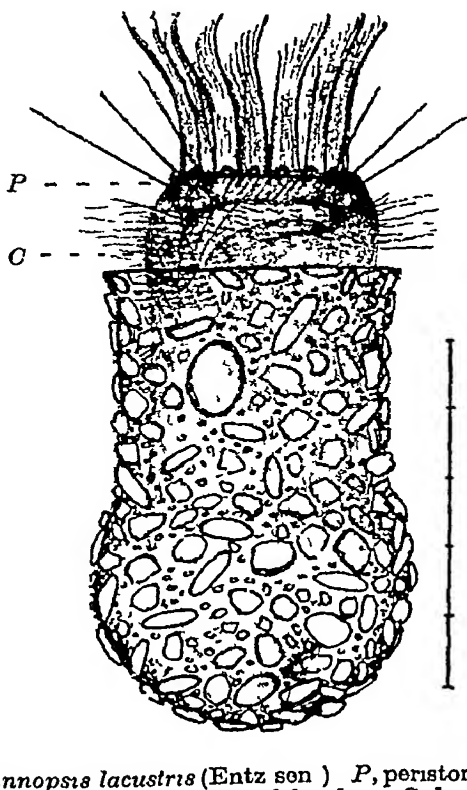


Fig 140 —*Tintinnopsis lacustris* (Entz sen) *P*, peristomial lip showing the bristles on its external border , *C* body cilia (After Faure-Fremiet)

Dimensions—Length of the animal about 80μ, length of the lorica about 65μ, width 40μ

Remarks—*Tintinnopsis lacustris* is a widely distributed species which has often been described (as, for instance, by Daday and Lepsi) under the name *Codonella lacustris* In both *Codonella* and *Tintinnopsis* the test is rigid and chitinous, and is open at the anterior end only In *Codonella* the test shows a definite neck-like portion, and the anterior decorations and openings are absent or feeble The species, as described by Entz sen (1885) and observed by Daday (1898), should be referred to the genus *Tintinnopsis* Entz jun has shown that there are two distinct forms of the species, the one described by Entz sen, as defined above and which he named forma *lævis*, and another in which the lorica is abruptly narrowed in the form of a cone, and presents a clearly reticulate structure, forma *reticulata* Fauré-Fremiet (1923) has given a full description of the former, and the figure given is taken from his work

Habitat—CEYLON, swamp of Madatugama and neighbourhood of Kalawewa Lake

164 **Tintinnopsis ovalis** Daday (Fig 141)

†*Tintinnopsis ovalis*, Daday, 1898, p 8
Tintinnopsis ovalis, Kahl, 1930–5, p 517, fig 82, *46*

Lorica uniformly oval, widening from the oral end, and broadly rounded posteriorly

Length 38–45μ

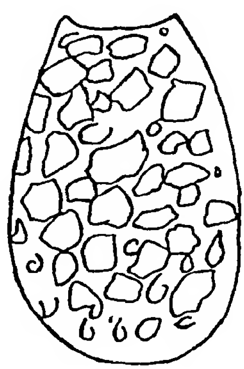


Fig 141—*Tintinnopsis ovalis* Daday Lorica only shown (After Daday)

Remarks—Entz jun regards this form as a modification of *Tintinnopsis* (*Codonella*) *lacustris*

Habitat—Swamp of Madatugama CEYLON

INCERTÆ SEDIS

Genus **OCTOCIRRUS** Madhava Rao, 1928

Characters of the genus not given

165 Octocirrus sphæratus Madhava Rao (Fig 142)

†*Octocirrus sphæratus*, Madhava Rao, 1928, p 116, pl ii, figs 3-5

Body somewhat ovoid, broadly rounded anteriorly and narrower posteriorly At the anterior end and helping in locomotion there are eight cirri as long as the body Cytoplasm differentiated into ectoplasm and endoplasm Contractile vacuole single, median Macronucleus and micro nucleus not observed Encysts under unfavourable conditions, and immediately after encystment it exhibits short cilia all round the body (*sic*)

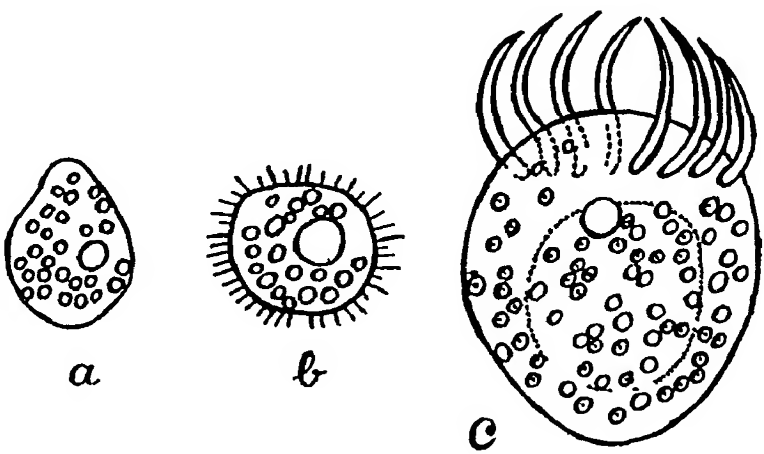


Fig 142 —*Octocirrus sphæratus* Madhava Rao *a*, cyst, *b*, stage, with cilia all round, *c*, adult stage (After Madhava Rao)

Dimensions —Length of the body 30μ

Remarks —This form is not adequately characterized, for such important characters as the peristome, macronucleus and micronucleus are not described The encysted condition is described as ciliated, which is very unusual It may have been an imperfectly observed *Strombidium*

Habitat —Soil MYSORE

III. Suborder *ENTODINIOMORPHA* Reichenow.

Body generally oval, often somewhat dorso-ventrally flattened. Body cilia generally absent. The adoral zone consists of cirri, forms a complete circle round the peristome, and is continued further backwards for a short extent. In certain genera one or more additional zones of cirri present on different parts of the body, quite apart from the peristome. Contractile vacuoles one or more. Macronucleus usually band-shaped, elongated in the direction of the long axis of the body, lying between the oral funnel and the dorsal wall of the body. Micronucleus single, lying close to or in a depression of the macronucleus. The posterior end of the body often drawn into spines and processes of various forms and arrangement. Endoparasites, almost exclusively of the Ungulate mammals. They occur in the rumen or the reticulum of the stomach of the ruminants, in the cæcum of the horse, or the intestine of the chimpanzee and gorilla, and certain small rodents of South America.

The rumen (paunch) and the reticulum (honeycomb) of the ruminant stomach are œsophageal derivatives, and as such contain no glands to secrete either acid or ferments. The contents consist of water and large quantities of saliva mixed with the partially triturated food of the animal, which consists of succulent or dried plants and grain. The fluid serves as an ideal medium for the growth of Ciliates, Flagellates, amœbæ, and Bacteria, and there is a Protozoan fauna more or less specific to the ruminants.

By some these organisms are regarded not as parasites, but as symbionts that assist in digestion and are themselves digested lower down the alimentary canal. The few that escape being digested pass out with the fæces and encyst on the grass. The cysts are swallowed with the grass and infect other hosts.

Identification Table of Families.

1 (2) Adoral zone of membranelles always present, and in addition a dorsal zone of membranelles which are directed forwards, or a number of accessory membranelle zones may be present. [St., p. 274
Ophryoscolecidæ

2 (1) Besides the adoral zone at least two broad rows of cirri present, which spring from the anterior wall of the furrow and have their points directed backward. **Cycloposthidæ*** Poche

Family OPHRYOSCOLECIDÆ Stein, 1867.

Parasitic forms of curious shapes with a thick periplast and a retractile peristome Cilia generally absent The adoral zone of membranelles is a complete circle, and in some genera there is an additional ring of cirri, also directed forwards, situated at the bottom of a furrow These cirri are also capable of being drawn backwards, in which condition the margins of the groove close over them Posterior end of the body often drawn out into spines or other processes of peculiar form and arrangement The family is almost entirely confined to the stomach of ruminants

The original genera included in the family Ophryoscolecidæ—*Entodinium*, *Diplodinium*, and *Ophryoscolex*—have continually been split up and recombined as our knowledge of their morphology has increased The genus *Diplodinium* was established by Schuberg (1888) to include species of Ophryoscolecidæ having a short dorsal membranelle zone in addition to the adoral membranelle zone Crawley (1923) set up the genus *Epidinium*, including in it species with the dorsal zone located considerably behind the level of the adoral zone, thus separating Sharp's *Diplodinium ecaudatum* from *Diplodinium* s str The main skeletal complex of *Epidinium* is similar to that of *Ophryoscolex*, being composed of three plates in each Two species of *Epidinium*, in which the main skeletal complex consists of five plates, have been separated into a new genus *Epiplastron* by Kofoid and MacLennan (1933) Awerinzew and Mutafowa (1914) described the genus *Metadinium*, which Buisson (1923) and Dogiel (1927) considered unjustified, but Kofoid and MacLennan (1932) have re-established it *Diplodinium* was further revised by Dogiel (1927) and divided into four subgenera—*Anoplodinium*, *Eudiplodinium*, *Polyplastron*, and *Ostracodinium*—without retaining the name *Diplodinium* for one of the subgenera, as required by the International Rules of Zoological Nomenclature Since the type-species *D dentatum* falls within the subgenus *Anoplodinium*, Kofoid and MacLennan consider the name *Anoplodinium* as a synonym of *Diplodinium*, the true name of the typical subgenus

Kofoid and MacLennan consider that the four subgenera established by Dogiel show important differences in nuclear structure and skeletal parts which distinctly separate them, they therefore raise these subgenera to full generic rank As they found two distinct groups of species included in *Diplodinium* s str, *Diplodinium* is further restricted, and a

new genus, *Eodinium*, described *Eudiplodinium* has been restricted, and a new genus, *Eremoplastron*, established Lastly, Dogiel's original description of *Polyplastron* has been retained, and the species described by him later (1928) has been put in a genus *Elytroplastron*

In the two genera *Polydinium* and *Elephantophilus* recently described by Kofoid (1935) there are numerous accessory membranelle zones extending spirally over the elongated body The family Ophryoscolecidæ may be divided into two subfamilies as follows —

1 (2) With an adoral membranelle zone, and with or without a dorsal zone One to five skeletal plates Contractile vacuoles usually one to twelve in number, located on the dorsal side adjacent to the macronucleus [Kofoid, p 275 OPHRYOSCOLECINÆ

2 (1) With an adoral membranelle zone, but without a dorsal zone With numerous accessory membranelle zones in a descending right spiral over the elongated body One to three skeletal plates Contractile vacuoles numerous, in irregular rows posterior to the accessory membranelle zones [Kofoid, p 356 POLYDININÆ

1 Subfamily OPHRYOSCOLECINÆ Kofoid, 1935.

Ophryoscolecidæ with an adoral membranelle zone and with or without a dorsal zone One to five skeletal plates present Contractile vacuoles usually one to twelve in number, located on the dorsal side adjacent to the macronucleus

Key to Indian Genera

1 (3) With only one adoral membranelle zone, no dorsal membranelle zone 2

2 No skeletal plates, only one contractile vacuole, macronucleus simple, band-shaped, rarely oval, with or without posterior spines [p 277 ENTODINIUM St,

3 (1) With a short dorsal membranelle zone in addition to the adoral zone 4

4 (20) With dorsal membranelle zone on the same level as the adoral zone 5

5 (8) No skeletal plate 6

6 (7) Macronucleus straight, rod-like, beneath the dorsal surface of the body, two contractile vacuoles [MacL, p 309 EODINIUM Kof &

7 (6) Macronucleus with its anterior third bent ventrally at an angle of 30°–90°, beneath the right surface of the body, two contractile vacuoles [p 312. DIPLODINIUM Schub,

8 (5) With one or more skeletal plates 9
9 (15) With a single skeletal plate beneath the right surface 10
10 (13) Skeletal plate narrow 11
11 (12) Macronucleus triangular or rod like, with its anterior end often bent ventrally, two contractile vacuoles [& MacL, p 324
EREMOPLASTRON Kof
12 (11) Macronucleus rod-like, with its anterior end enlarged to form a hook with its concavity towards the dorsal aspect, cuticle and ectoplasm thick, two contractile vacuoles [p 330
EUDIPLODINIUM Dog
13 (10) Skeletal plate broad 14
14 Two to six contractile vacuoles in a row beneath dorsal surface, œsophageal fibres heavy and extending to posterior end of the body [p 335
OSTRACODINIUM Dog,
15 (9) With two or more skeletal plates 16
16 (19) With two skeletal plates beneath the right surface 17
17 (18) Macronucleus large, with two or three prominent dorsal lobes, contractile vacuoles two, lying close to the macronucleus, cuticle and ectoplasm heavy [Mutaf, p 332
METADINIUM Awer &
18 (17) Macronucleus narrow, rod-like, contractile vacuoles two, separated from the macronucleus, cuticle and ectoplasm thin [& MacL, p 329
DIPLOPLASTRON Kof
19 (16) With two skeletal plates beneath right surface, a small plate beneath ventral surface, and a long plate beneath the left surface; cuticle and ectoplasm heavy, conspicuous œsophageal fibrils [Kof & MacL, p 334
ELYTROPLASTRON
20 (4) With dorsal membranelle zone located farther back on the body
21 (22) Dorsal membranelle zone behind the anterior end of the body, main skeletal complex composed of three plates not extending into the main caudal spine, two contractile vacuoles [p 343
EPIDINIUM Crawley,
22 (21) Dorsal membranelle zone forming a girdle extending three fourths the distance around the middle of the body, skeletal complex of three plates extending the length of the right ventral side, even into the main caudal spine, 9–15 vacuoles ranged round the body in two transverse rows [p 352
OPHRYOSCOLEX St,

Genus ENTODINIUM Stein, 1858

Entodinium, Stein, 1858 p 69, 1859 *a*, p 58, 1867, pp 164, 168, Kent, 1880–2 p 653 Schuberg, 1888, pp 366–7, Bütschli, 1887–9, p 1738, Dogiel 1925 *d*, pp 43–65, 1927 pp 35–71, 1928 *b*, pp 328–9, Calkins 1926 p 409, 1933 p 513, Wenyon, 1926, p 1211, Reichenow, 1929, p 1199, Kofoid & MacLennan, 1930, pp 471–544, pls xlix–lii & 17 text-figs, Kofoid & Christenson, 1934 pp 347–52, Das-Gupta, 1935, pp 160–5

Body ovoid, anterior end with a spiral row of cirri (adoral

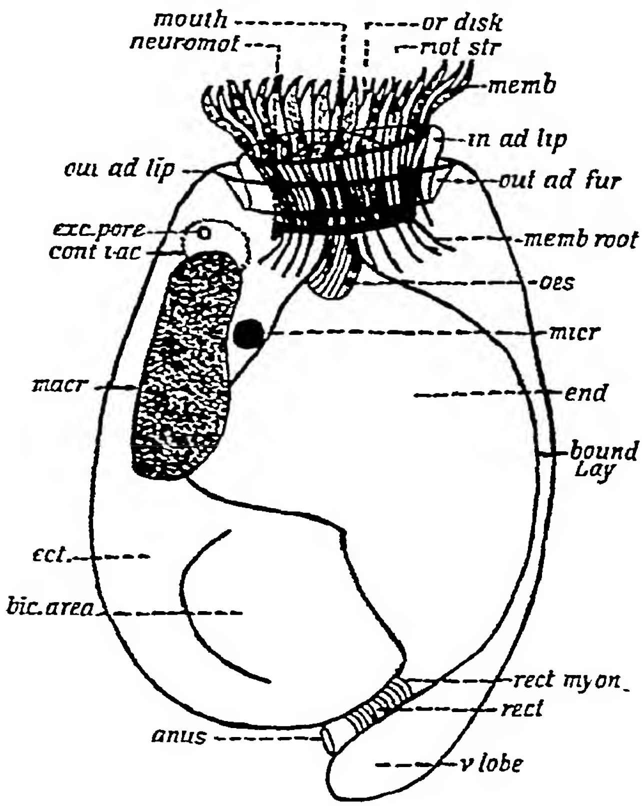


Fig 143—*Entodinium biconcavum* Kof & MacL Semidiagrammatic lateral view showing location and structure of the principal organelles The surface striations are omitted for the sake of clearness × 2000 *anus* anus *bic area* biconcave area, *bound lay* boundary layer, *cont vac* contractile vacuole *ect* ectoplasm, *en* endoplasm *exc pore*, excretory pore, *in ad lip* inner adoral lip, *macr*, macronucleus *memb* membranelle *memb root* membranelle rootlet *micr* micronucleus, *cyto* cytostome, *mot str* motor strand, *neuromot* neuromotorium, *oes*, œsophagus *or disk* oral disk, *out ad fur*, outer adoral furrow *out ad lip* outer adoral lip, *rect myon* rectal myoneme *rect*, rectum [illegible]
(After Kofoid & MacLennan)

membranelle zone) leading to a cytostome and œsophagus No dorsal membranelle zone No skeletal plates Only one contractile vacuole Macronucleus simple band-shaped, rarely oval, micronucleus ventral and situated somewhat to the left of the macronucleus With or without posterior spines Small to medium-sized (20–120 μ long)

The principal features of structure can be clearly seen from the accompanying figure, and a careful study of this figure will be useful in following the descriptions of various species

Remarks—Jameson (1925) recorded *E bursa* Stein and *E dubardi* Buisson, and described *E ovale* from the stomach of the mouse-deer from Ceylon, Kofoid and MacLennan (1930) have described twenty species from the stomach of *Bos indicus* from India and Ceylon Kofoid and MacLennan have been able to arrange more than half of these species in groups, each consisting of two or more species, which show a marked similarity in a number of different structures, particularly in the shape and position of the macronucleus and contractile vacuole, the shape of the endoplasmic sack, and the structure of the rectum, and which differ from one another in only one or two features, usually spines, size, shape, or proportions These groups are adopted in the following pages

Key to Indian Species

1 (28)	Without caudal processes	2
2	Very small to medium sized, body laterally compressed, not curved	3
3 (5)	Macronucleus bent anteriorly in a hook-like manner	4
4	Very small, oval, 20–40 μ	*E ovale* Jameson, [p 303
5 (3)	Macronucleus not bent	6
6 (8)	Macronucleus not extending beyond the anterior half of the body	7
7	Medium sized, oval, 51–80 μ macronucleus short and massive, scarcely reaching the middle	*E anteronucleatum* [*læve* Dog, p 294
8 (6)	Macronucleus extending beyond the anterior half of the body	9
9 (22)	Very small or small	10
10 (13)	Very small	11
11 (12)	Ovoid, 22–32 μ, macronucleus narrow and long, over ½ body-length	*E nanellum* Dog, [p 302
12 (11)	Elongated oval, tapering posteriorly, 26–35 μ, macronucleus ovoidal or spherical, situated about the middle of the body	*E chatterjeei* Das [Gupta, p 297
13 (10)	Small, over 30 μ	14
14 (21)	Body ovoid	15
15 (16)	Small, markedly elongated (ratio of length to breadth 2 35), endoplasmic sack with a characteristic concavity	*E elongatum* Dog, [p 291
16 (15)	Small, not markedly elongated (ratio of length to breadth 1 5–1 7), endoplasmic sack without a concavity	17

17 (18)	Body broad (ratio of length to breadth 1 5–1 6), dorsal and ventral sides convex .	*E dubardi* Dog, p 284
18 (17)	Body less broad (ratio of length to breadth 1 7–1 75)	19
19 (20)	Dorsal and ventral sides nearly parallel	*E simplex* Dog, p 308
20 (19)	Dorsal and ventral sides convex	*E ovoideum* Kof & MacL, p 305
21 (14)	Small, pyriform, 39–46 μ, macronucleus curved, club-shaped, long ⅔ body-length	*E contractum* Kof & Chr., p 298.
22 (9)	Medium sized or large	23
23	Medium sized, ellipsoid, above 50 μ .	24
24 (25)	Macronucleus long, beginning close to the anterior end of the body and extending ⅔ body-length	*E ovinum* Dog, p 304
25 (24)	Macronucleus long, over ¾ body-length . .	26
26 (27)	Mouth smaller, sides of the body more strongly convex	*E ellipsoideum* Kof & MacL, p 284
27 (26)	Mouth larger, sides of the body less convex	*E bursa* St, p 282.
28 (1)	With caudal lobes or spines .	29
29 (46)	With only one caudal process	30
30 (38)	Caudal process in the form of a prominent ventral lobe .	31
31 (36)	Posterior dorsal region not with biconcave areas	32
32 (35)	Small	33
33 (34)	Ellipsoid, 39–51 μ, macronucleus long, from ⅔ to ¾ body-length	*E longinucleatum* Dog, p 286
34 (33)	Rhomboid, 30–47 μ, macronucleus thin, wedge shaped, from ½ to ⅔ body-length .	*E rhomboideum* Kof & MacL, p 306
35 (32)	Medium sized, 52–82 μ, pre anal lobe obliquely truncated, macronucleus not extending beyond the middle of the body	*E anteronucleatum monolobum* Dog, p 295
36 (31)	Posterior dorsal region with bilateral biconcave areas .	37
37	Small, oval, 28–41 μ, macronucleus short stumpy to long band-like, set at an angle to the dorsal mid-line	*E biconcavum* Kof & MacL, p 290.
38 (30)	Caudal process in the form of a pre-anal spine	39
39 (41)	Ventral spine small, parallel to main axis	40
40	Very small, oval, 24–30 μ, macronucleus broad, wedge shaped, from ½ to ⅔ body-length	*E brevispinum* Kof & MacL, p 296
41 (39)	Ventral spine large, curved dorsally	42
42 (45)	Very small	43
43 (44)	Elongated oval, 28–41 μ, macronucleus narrow, band like, from ½ to ¾ body-length .	*E rostratum* Fior, p 288
44 (43)	Oval, 25–32 μ, macronucleus broad, elongated, from ½ to ⅝ body length	*E laterospinum* Kof & MacL, p 301
45 (42)	Small, rotund, 40–53 μ, macronucleus slightly curved rod like, about ⅕ body length	*E curtum* Kof & Chr, p 283

46 (29)	With more than one caudal process	47
47 (66)	With two caudal processes	48
48 (64)	With dorsal and ventral spines or processes	49
49 (52)	With two spines, one dorsal and one ventral	50
50 (51)	Small, 38–58 μ, with distinct dorsal fin with a sharp dorsal spine at its posterior end, and a small ventral spine, macronucleus band like, $\frac{1}{2}$ body length	*E pisciculum* Kof & [MacL, p 287
51 (50)	Small, 38–51 μ, with heavy dorsal and ventral spines, macronucleus band-like, $\frac{3}{4}$ body-length	*E gibberosum* Kof & [MacL, p 300
52 (49)	With two processes, one dorsal and one ventral	53
53 (55)	Only one of the processes lobe like	54
54	Small, broad, 30–46 μ, pre anal process rounded, lobe like, post anal pointed spine, macronucleus elongated	*E loboso spinosum* [Dog, p 285
55 (53)	Both processes more or less lobe like	56
56 (62)	Macronucleus elongated, sausage-shaped	57
57 (59)	Macronucleus not extending beyond the middle	58
58	Medium sized both lobes short	*E anteronucleatum* [*dilobum* Dog, [p 295
59 (57)	Macronucleus extending beyond the middle	60
60 (61)	Very small, subspherical, posteriorly narrowed, 30–40 μ, caudal lobes transversely truncated, lying close to each other, separated by a narrow slit, macronucleus elongated	*E. bimastus* Dog, [p 295
61 (60)	Short and broad, 42–55 μ, caudal lobes more or less pointed, separated by a distinct bay	*E furca dilobum* Dog, [p 299
62 (56)	Macronucleus spherical, situated about the middle of the body	63
63	Medium sized, broad, 50–60 μ, caudal lobes small and pointed	*E setnai* Das Gupta, [p 307
64 (48)	With two caudal spines, one on each side of the ventral lobe	65
65	Very small, oval, 31–40 μ, posterior dorsal region depressed laterally, forming bilateral biconcave areas, macronucleus short ovoid to long band-like, set at an angle to the dorsal mid line	*E bifidum* (Dog), [p 291
66 (47)	With three caudal processes	67
67 (82)	With one dorsal and two ventral spines, one on each side of ventral lobe	68
68 (71)	Contractile vacuole in the middle of the left lateral surface	69
69 (70)	Very small, ellipsoid, 19–28 μ, right ventral spine a small triangular flap, macronucleus broad, wedge shaped, $\frac{1}{2}$ to $\frac{2}{3}$ body-length	*E laterale* Kof & [MacL, p 292
70 (69)	Very small to small, broad, 29–45 μ, right ventral spine broad flange like,	

	macronucleus broad, wedge shaped, $\frac{1}{2}$ to $\frac{2}{3}$ body-length	*E rectangulatum* Kof [& MacL, p 293
71 (68)	Contractile vacuole to the left of the macronucleus	72
72 (79)	Postero dorsal region without bilateral biconcave areas	73
73 (76)	Macronucleus elongated	74
74 (75)	Very small, short and stout, 25–39 μ, strongly convex surfaces, macronucleus $\frac{4}{5}$ of the body-length	*E acutonucleatum* [Kof & MacL, p 286
75 (74)	Medium sized to large, strongly convex surfaces, macronucleus may or may not extend beyond the middle of the body	*E caudatum* St, p 296
76 (73)	Macronucleus ovoid, not extending beyond the middle	
77 (78)	Very small, broadly oval, 25–30 μ, dorsal spine as long as the body	*E ovoido nucleatum* [Das Gupta, p 305
78 (77)	Very small, broadly oval, 30–35 μ, dorsal spine not very long, arising from the right lateral surface	*E chendræ* Das [Gupta, p 299
79 (72)	Postero dorsal region with bilateral biconcave areas	80
80 (81)	Small, oval, 32–42 μ, dorsal spine broad, triangular, ventral spines large, macronucleus short to long band like, $\frac{1}{2}$ to $\frac{2}{3}$ of the body length, set at an angle to dorsal mid-line	*E acutum* Kof & [MacL, p 289
81 (80)	Small oval, 34–40 μ, dorsal spine short, narrow, ventral spines large, the right ventral simple or bifurcate, macronucleus short, broad, $\frac{1}{2}$ to less than $\frac{2}{3}$ the body length, set at an angle to the dorsal mid-line	*E aculeatum* Kof & [MacL, p 289
82 (67)	With one dorsal spine, one ventral spine, and one lateral lobe or spine	83
83 (84)	Very small, short, broad, ellipsoid, 22–33 μ, with three prominent ribs running the length of the body, dorsal and left ventral ribs terminating in caudal spines, thin blade like right ventral rib in the lateral lobe, macronucleus very short, stout, $\frac{2}{3}$ to almost the body-length, following the spiral course of the dorsal rib	*E tricostatum* Kof & [MacL, p 308
84 (83)	Small, broad, 25–40 μ, spines long, triangular, one dorsal, one ventral, and one large spine on the left side, macronucleus wedge shaped, $\frac{1}{2}$ to $\frac{3}{4}$ body length	*E indicum* Kof & [MacL, p 301

"BURSA" GROUP —The features of this group are stated to be their large size (60–122 μ) and their habit of eating other Ciliates The macronucleus, the vacuole, and the heavy slit rectum furnish evidence of close relationship *E bursa* and *E ellipsoideum* belong to this group, and *E curtum*, *E dubardi*, and *E loboso-spinosum*, though smaller in size, may also be placed here

166 Entodinium bursa Stein (Fig 144)

Entodinium bursa, Stein, 1858, pp 69–70, 1867, p 164, Schuberg, 1888, pp 366, 404–9, figs 6, 29
†*Entodinium bursa*, Jameson, 1925, p 407
†*Diplodinium bursa*, Jameson, 1925, p 408
Entodinium vorax forma *vorax*, Dogiel, 1925 *a*, 1927, pp 46–7, fig 10, *a*, *b*
Entodinium bursa, Dogiel, 1927, p 68, fig 35, Kofoid & MacLennan, pp 496–7
†*Entodinium vorax*, Das Gupta, 1935, p 160

Body stoutly ellipsoid, with relatively plane surfaces, length 1 4 times the dorso-ventral diameter, the anterior end flattened to form the oral area, posterior end rounded Cytostome relatively large Contractile vacuole single, lateral, somewhat behind the anterior end Anal groove leads into

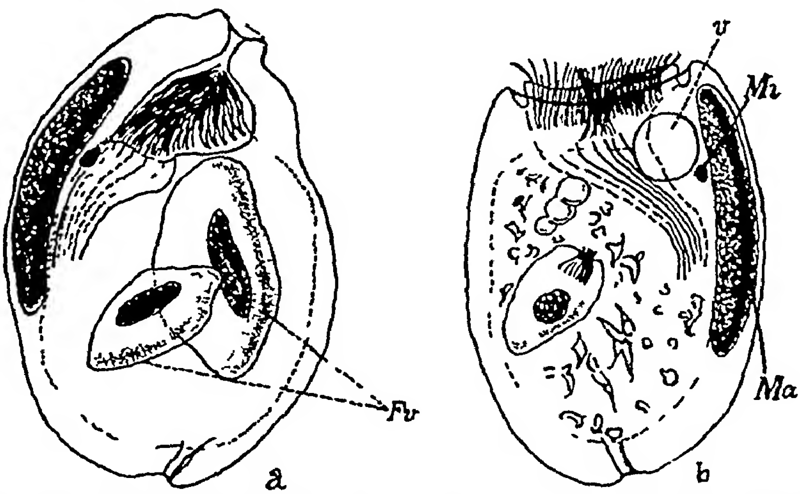


Fig 144 —*Entodinium bursa* St *a*, with retracted, *b*, with expanded adoral zone *Fv*, small *Entodinium* specimens in the endoplasmic sack, *Ma*, macronucleus, *Mi*, micronucleus, *v*, contractile vacuole (After Dogiel)

a depression at the posterior end of the body Macronucleus large, cylindrical, extending from a little distance behind the oral end to almost the posterior end of the body Micronucleus small, lying close beside the macronucleus

Dimensions —Length 80–121 μ, breadth 52–83 μ

Feeds on other Ciliates

Remarks.—Dogiel (1927) lists *E bursa* among the "species incertæ," and thinks that the form described under this name by Schuberg was a complex of species, all of which are now listed under different names, e g, *E simplex*, *E ovinum*, *E dubardi*, *E parvum* and *E vorax*, and, further, that there is now left no non-caudate form to which the name *E bursa*

could apply Dogiel has ignored the accepted principle of nomenclature, that in revising a species some part must be left under the original name Kofoid and MacLennan (1930) consider *E vorax vorax* Dogiel, 1925, to be a synonym of *E bursa* Stein

In *E bursa* the cytostome is larger than in *E ellipsoideum*, and in expanded forms the sides are nearly parallel The Ceylonese form closely resembles the European form, but the nucleus is bigger

Habitat —Stomach of *Tragulus meminna* Milne-Edwards (mouse-deer) Ceylon The material was collected by Dobell (1910) Also rumen of *Capra hircus* Linn BENGAL, Calcutta

167 **Entodinium curtum** Kofoid & Christenson (Pl X, fig 2)

†*Entodinium curtum*, Kofoid & Christenson, 1934, pp 350–1, pl xxi, fig 5, fig A, 5, 6

Body rotund and stout, 1 21–1 56 dorso-ventral diameters in length Dorsal and ventral surfaces convex, with the ventral convexity more prominent One short ventral spine at the posterior end Oral area circular and occupying a large part of the anterior face of the animal Cytostome tilted to the left Œsophagus is long, and curving to the right and dorsalwards ends on a level with the posterior third of the macronucleus Its wall is composed of a number of feebly staining longitudinal fibrils Boundary layer enclosing the endoplasmic sack lies directly underneath the pellicle on the lateral and ventral surfaces of the body, but forms a concavity dorsally for the ventral face of the macronucleus and the contractile vacuole Contractile vacuole to the left of the anterior end of the macronucleus Rectum sloping, with the anal opening at the extreme posterior end of the animal, just dorsal to the small spine Macronucleus a slightly curved, stout, rod-like structure, rounded at both ends, lying in the dorsal middle line and extending about four-fifths of the length of the body Micronucleus small, subspherical, close to the ventral surface of the macronucleus, at about one-fourth its length from its anterior end

Dimensions —Length 40–53μ

Feeds on Bacteria and very small pieces of plant debris

Remarks —*E curtum* closely resembles *E ellipsoideum* in general body form and proportions, in shape of the macronucleus and type of œsophagus, but differs in its smaller size and the possession of a short ventral spine

Habitat —Stomach of *Bos gaurus* H Smith Mulehole, Mysore

168 **Entodinium dubardi** Buisson (Fig 145)

Entodinium dubardi, Buisson, 1923 *b*, p 98
†*Entodinium dubardi*, Jameson 1925, p 407
Entodinium dubardi forma *dubardi*, Dogiel, 1927, p 42 fig 5
Entodinium dubardi dubardi, Wertheim, 1935, pp 228–9, fig 5
†*Entodinium dubardi*, Das Gupta, 1935, p 160

Body oval, length 1 55 times the dorso-ventral diameter, the anterior end truncated, strongly flattened laterally Cytostome relatively small Contractile vacuole single, situated to the left of the anterior end of the macronucleus Macronucleus large, band-shaped or sausage-shaped, somewhat narrowed posteriorly Micronucleus elongated, situated at or in front of the middle of the macronucleus

Dimensions —Length 30–40 μ, width 20–25 μ

Remarks —The relatively large ectoplasmic expansions of the sides and the prominent anal canal are the characteristic features of the species In the forms from Ceylon the

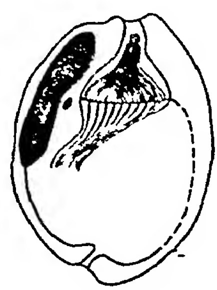


Fig 145 —*Entodinium dubardi* Buisson (After Buisson)

nucleus is larger, occupying the whole length of one side, and, as a rule, does not taper to a point In addition no striping could be detected on the cuticle In the specimens from *Capra hircus* the macronucleus is variable in size and usually reaches the middle of the dorsal side

Habitat —Stomach of *Tragulus meminna* Milne-Edwards (mouse-deer) CEYLON The material was collected by Dobell (1910) Also rumen of *Capra hircus* Linn BENGAL, Calcutta

169 **Entodinium ellipsoideum** Kofoid & MacLennan (Pl IV, fig 17)

†*Entodinium ellipsoideum*, Kofoid & MacLennan, 1930, pp 499–500, pl lii, fig 17, fig F

Body a stout ellipsoid, length 1 20–1 67 times the dorso-ventral diameter, the anterior end flattened to form the oral area laterally compressed Cytostome relatively small (0 38–

0 64 dorso-ventral diameters in diameter) Contractile vacuole to the left of the macronucleus, somewhat below the anterior end Anus a narrow transverse slit Macronucleus large, triangular, extending along the dorsal mid-line from the oral region past the middle of the body Micronucleus ellipsoidal, lying in the middle half on the left side of the macronucleus, or slightly ventral

Dimensions —Length 65–120 μ

Voracious feeder

Remarks —The species is distinguishable from *E bursa* by the smaller cytostome and more strongly convex sides of the body

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

170 **Entodinium loboso-spinosum** Dogiel (Fig 146)

Entodinium dubardi (part) Buisson, 1923 *b*
Entodinium dubardi forma *spinosum*, Dogiel, 1925 *a*, pp 119–20
Entodinium loboso spinosum, Dogiel, 1927, pp 60–1, fig 27, *a–c*
†*Entodinium loboso spinosum*, Das Gupta, 1935, p 160

Body moderately short and broad, both dorsal and ventral surfaces distinctly convex Anterior end truncated, posterior

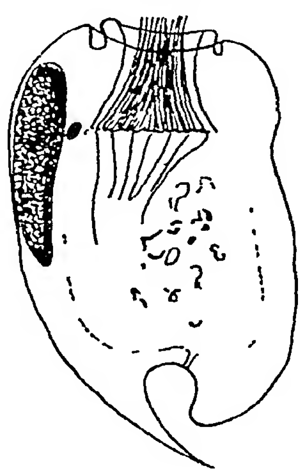


Fig 146 —*Entodinium loboso spinosum* Dogiel (After Dogiel)

end provided with two processes One of these processes is pre-anal and is gently rounded at the end, the other process arises from the dorsal (postanal) part of the posterior end of the body, is broad at its base, elegantly curved, and narrows sharply into a spine. Ciliary apparatus and endoplasmic sack do not present any characteristic feature Macronucleus elongated, dorso ventrally compressed, and closely

fitting against the dorsal surface of the body Micronucleus lies about the middle of the macronucleus

Dimensions of the examples from cattle and sheep —Length 30–46 μ, breadth 20–31 μ, ratio of length to breadth 1 5

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

"LONGINUCLEATUM" GROUP —This group is characterized by a long macronucleus extending along the length of the dorsal mid-line, a heavy boundary layer, and a well-developed slit-like rectum Its members are short and stout, with strongly convex surfaces *E acutonucleatum* and *E longinucleatum* belong to this group

171 **Entodinium acutonucleatum** Kofoid & MacLennan (Pl I, fig 1)

†*Entodinium acutonucleatum*, Kofoid & MacLennan, 1930, pp 503–4, pl xlix, fig 1, fig G, 1, 2, Kofoid & Christenson, 1934 1934, pp 347–8, pl xxv, fig 1, fig A, 1, 2 13–18

Body short and stout, length 1 10–1 44 times the dorso-ventral diameter, laterally compressed Dorsal surface continued posteriorly in a sharp, but relatively broad, dorsal spine curving ventrally Ventral lobe present, but relatively small, with two small spines, one on each side, curving dorsalward Oral area inclined ventrally Endoplasmic sack fairly clearly defined by the boundary layer Contractile vacuole close to the left of the anterior end of the macronucleus Rectum a wide thin-walled slit, opening by a small oval anus Macronucleus elongated, extending along four-fifths of the dorsal mid-line Micronucleus a small, ellipsoidal to spherical body, lying on the left ventral side of the anterior quarter of the macronucleus

Dimensions —Length 25–39 μ

Feeds on plant débris, particularly pollen grains

Remarks —The specimens from *B gaurus* show greater variation in size and shape of the extremities of the macronucleus, the spines are relatively longer, and the notch between the ventral spines is deeper than in those from *B indicus*

Habitat —Stomach of *Bos indicus* Linn, MADRAS, Coonoor, CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore

172 **Entodinium longinucleatum** Dogiel (Pl I, fig 2)

Entodinium longinucleatum, Dogiel, 1925*d*, pp 47–8, fig 6, 1927, pp 48–9, fig 12

†*Entodinium longinucleatum*, Kofoid & MacLennan, 1930, pp 501–2, pl xlix, fig 2, fig G, 3, 4, Kofoid & Christenson, 1934, pp 351–2, pl xxv, fig 3, fig A, 3, 4, Das Gupta, 1935, p 160

Body ellipsoid, length 1 21–1 52 times the dorso-ventral diameter, anterior end broad and blunt, flattened laterally Oral area relatively small Ventral lobe prominent Endoplasmic sack has a distinct boundary layer Contractile vacuole close against the left side of the macronucleus, slightly anterior to the micronucleus Rectum a broad transverse slit Anus a narrow elliptical opening on the dorsal side of the base of the ventral spine Macronucleus elongate, extending along the dorsal mid-line from two-thirds to three-quarters of the length of the body Micronucleus small, spherical or ovoid, on the ventral side of the anterior quarter of the macronucleus

Dimensions —Length 39–51 μ

Feeds on plant débris, particularly pollen grains

Remarks —This species differs from *E acutonucleatum* in that the only caudal structure present is the ventral lobe instead of a lobe plus two lateral spines as in that species

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore, rumen of *Capra hircus* Linn BENGAL, Calcutta

"ROSTRATUM" GROUP —This group is marked by a straight rod-like macronucleus, with the contractile vacuole lying anterior to it, and by the presence of a conspicuous excretory canal The boundary layer is very weak and the rectum a simple cylinder with two steeply spiral myonemes rising from it It includes *E pisciculum* and *E rostratum*

173 **Entodinium pisciculum** Kofoid & MacLennan (Pl II, fig 9)

†*Entodinium pisciculum*, Kofoid & MacLennan, 1930, pp 507–8, pl 1, fig 9, fig H, 3, 4

Body long and slim, length 1 76–2 38 times the dorso-ventral diameter, gracefully tapering posteriorly to form the ventral spine, laterally compressed Dorsal surface convex ventral surface nearly plane A thin cuticular flange along the dorsal mid-line with a fusiform projection near the anterior end and a sharp dorsal spine on the posterior end. Cytostome in contracted specimens a narrow transverse slit. Contractile vacuole directly anterior to the macronucleus. Rectum in the base of the ventral spine, with a small circular anus Macronucleus straight, rod-like or band-like, extending along the dorsal mid-line in the middle half of the body four to six times as long as wide Micronucleus in a small depression in the macronucleus along the middle of the left ventral edge

Dimensions —Length 38–58 μ

Feeds on Bacteria and small Flagellates

Remarks—The shape of the body, with the prominent dorsal "fin," gives *E pisciculum* a strikingly fish-like appearance It is a large *E rostratum*, whose morphology has been complicated by the addition of a flange along the dorsal mid-line

Habitat—Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON Colombo

174 **Entodinium rostratum** Fiorentini (Pl II, fig 6)

Entodinium rostratum, Fiorentini, 1889, p 19, pl ix *a*, fig 3, Eberlein, 1895, pp 270–1, pl xviii, fig 22, Schweier, 1900, pp 92–3 pl ii, fig 36, Buisson, 1923 *b*, pp 93–5, fig 31

Entodinium rostratum forma *rostratum*, Dogiel, 1927, pp 52–3, fig 18, *a–f*

†*Entodinium rostratum*, Kofoid & MacLennan, 1930, pp 505–7, pl 1, fig 6, fig H, 1, 2

Non *Entodinium rostratum*, Gunther, 1900, pp 640–8, figs 12–14

Body rather long and slim, length 1 50–2 18 times the dorso-ventral diameter Dorsal surface convex, ventral surface concave The dorsal side terminates in a short, broad dorsal lobe, the ventral side in a heavy, blunt spine Cytostome in contracted forms a narrow transverse slit, in expanded forms circular Contractile vacuole directly anterior to the macronucleus Rectum at the base of the ventral spine, anus between the ventral spine and the dorsal lobe Macronucleus straight, rod-like, extending along dorsal mid-line in the middle half of the body, four to six times as long as wide Micronucleus in a small depression in the macronucleus, along the middle of the left ventral edge

Dimensions —Length 28–41 μ

Feeds entirely on Bacteria and small Flagellates

Remarks—The length of the tail and the degree of concavity of the ventral surface vary widely in this species The Indian specimens are of the short-tailed form

Habitat—Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

"BICONCAVUM" GROUP—This group possesses a macronucleus of ordinary length but set at an angle to the dorsal mid-line The endoplasmic-sack tapers posteriorly to form a cone, and the rectum is stout and cylindrical, reinforced with transverse, circular myonemes *E aculeatum*, *E acutum*, *E biconcavum*, *E bifidum*, and *E elongatum* are included in this group

175 **Entodinium aculeatum** Kofoid & MacLennan (Pl III, fig 12)

†*Entodinium aculeatum*, Kofoid & MacLennan, 1930, pp 515–17, pl li, fig 12, fig K

Body oval, length 1 31–1 43 times the dorso-ventral diameter, strongly compressed laterally Dorsal surface strongly convex, anterior portion of ventral surface convex, posterior portion flat or slightly concave A short narrow dorsal spine, two large caudal spines, one on each side of the reduced ventral lobe The right ventral spine extends farther towards the dorsal side, and may or may not be bifurcated Cytostome a small opening in the anterior projection Endoplasmic sack with its anterior portion shorter than in the other species of the group, but with the conical portion as long as in the other species Rectrum narrow, cylindrical, opening to the exterior by the anus Contractile vacuole near the dorsal mid-line, to the left of the macronucleus, somewhat behind its anterior tip Macronucleus a short, broad body, located along the dorsal border, extending from near the anterior end to past the middle of the body, set at an angle to the dorsal mid-line Micronucleus near the left ventral border of the middle third of the macronucleus

Dimensions —Length 34–40 μ

Feeds on small plant débris, rarely on Bacteria or Flagellates

Remarks —Throughout the Ophryoscolecidæ a major trend in their evolution is the increasing complexity of the caudal ornament accompanied by a considerable variation in the details of the spines among individuals of the same species The variation in a spine from simple to bifurcate, as seen in this species, has been described before by Dogiel from species of other genera

Habitat —Stomach of *Bos indicus* Linn CEYLON, Colombo

176 **Entodinium acutum** Kofoid & MacLennan (Pl III, fig 15.)

†*Entodinium acutum*, Kofoid & MacLennan, 1930, pp 514–15, pl li, fig 15, fig I, 3, 4

Body oval, length 1 25–1 68 times the dorso-ventral diameter, laterally compressed Convex on both dorsal and ventral surfaces Three spines of nearly equal length—a broad triangular postero-dorsal spine and two large caudal spines, one on each side of the reduced ventral lobe. Cytostome a small opening in the anterior projection Endoplasmic sack wide, tapering posteriorly to a cone Rectum narrow, cylindrical, opening to the exterior by the anus Contractile vacuole near the dorsal mid-line to the left of the macro-

nucleus somewhat behind its anterior tip Macronucleus varies from a short form to a long band, on the average longer than in the other species of this group, located along the dorsal border, extending from near the anterior end past the middle of the body, and set at an angle to the dorsal mid-line Micronucleus spherical, near the left ventral border of the middle half of the macronucleus

Dimensions —Length 30–42 μ

Feeds on small plant débris, rarely on Bacteria or Flagellates

Remarks —The posterior biconcave region, as present in *E biconcavum* and *E bifidum*, is represented in this species by a biconcave region with the heavy dorsal rim prolonged into a dorsal spine, there is, however, no tendency for the right ventral spine to become bifurcated as in *E aculeatum*

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

177 **Entodinium biconcavum** Kofoid & MacLennan (Pl III, fig 14, fig 143)

†*Entodinium biconcavum*, Kofoid & MacLennan, 1930, pp 509–11, pl li, fig 14, fig 1, 1, 2, Das Gupta, 1935, p 164

Body oval, length 1 15–1 52 times the dorso ventral diameter, laterally compressed Strongly convex on both dorsal and ventral surfaces, posterior dorsal region of the body depressed laterally, forming bilateral concave areas A small blunt ventral lobe is the only caudal projection Anterior end truncated at right angles to the main axis to form the broad oral area, adoral lips relatively heavy Endoplasmic sack wide, tapering posteriorly to form a cone Rectum narrow, cylindrical, pointing dorsally and opening to the exterior by the anus Contractile vacuole at the left of the anterior end of the macronucleus near the dorsal mid-line Macronucleus from a short stumpy to a long, thin band-like structure, extending along the dorsal border from the level of the attachment of the œsophagus to about the middle of the body, and set at an angle to the dorsal mid-line Micronucleus small, spherical, near the left ventral border of the anterior third of the macronucleus

Dimensions —Length 28–41 μ

Feeds on small plant débris, rarely on Bacteria or Flagellates

Remarks —This species is very similar to *E elongatum* Dogiel in the general shape of the body and macronucleus, conical endoplasmic sack, cylindrical rectum, small food particles and ventral lobe, but it differs from that species in size, relative body proportions and in having both surfaces convex, in *E elongatum* the dorsal side is convex and the ventral flat

The specimens from *Capra hircus* are larger, measuring 39–45 μ in length and 30–34 μ in dorso-ventral diameter, and the macronucleus is narrow towards its anterior end and massive towards the posterior

Habitat.—Stomach of *Bos indicus* Linn.: MADRAS, Coonoor, CEYLON, Colombo rumen of *Capra hircus* Linn · BENGAL Calcutta

178 **Entodinium bifidum (Dogiel)** (Pl III fig 13)

Entodinium rostratum forma *bifidum*, Dogiel, 1927, pp. 53–4, fig 19 *a–e*.
Entodinium rostratum forma *bifidum* aberration *ecaudata*, Dogiel, 1927, p 54, fig 19, *d*
†*Entodinium bifidum* Kofoid & MacLennan, 1930, pp 511–13, pl li, fig 13 fig J

Body oval length 1 50–1 90 times the dorso-ventral diameter laterally compressed Strongly convex on both dorsal and ventral surfaces posterior dorsal region of body depressed laterally, forming bilateral concave areas Two caudal spines one on each side of the ventral lobe Anterior end sharply truncated at right angles to the main axis to form a broad oral area: adoral lips relatively light Endoplasmic sack wide, with a posterior cone Rectum narrow, cylindrical pointing dorsalwards, and opening to the exterior by a small circular anus situated between the ventral lobe and the posterior portion of the biconcave area Contractile vacuole on the left of the anterior end of the macronucleus near the dorsal mid-line Macronucleus from a short ovoid to a long, thin, band-like body, along the dorsal border, but set at an angle to the dorsal mid-line Micronucleus small, spherical, near the left ventral border of the middle half of the body

Dimensions—Length 31–40 μ

Feeds on small plant débris, rarely on Bacteria or Flagellates.

Remarks—The caudal spines vary from short, insignificant projections to rather large spines

Habitat—Stomach of *Bos indicus* Linn. MADRAS, Coonoor.

179 **Entodinium elongatum Dogiel** (Fig 147)

Entodinium elongatum, Dogiel, 1927, pp 45–6 fig 9, *a–c*
†*Entodinium elongatum*, Das-Gupta, 1935, p 161

Body very elongated, ventral surface almost flat, dorsal surface slightly convex Posterior end of the body unarmed, somewhat obliquely truncated Endoplasmic sack not symmetrically oval but showing a dorsal diverticulum at its hinder end. Anal tube long, thin and extending quite up to the posterior end Contractile vacuole close to the anterior

end of the macronucleus Macronucleus short and thick, symmetrically rounded at both poles, and not thickened at its anterior pole Micronucleus lies about the middle of the macronucleus

Dimensions —Length 41–50 μ breadth 17–22 μ, ratio of length to breadth 2 35

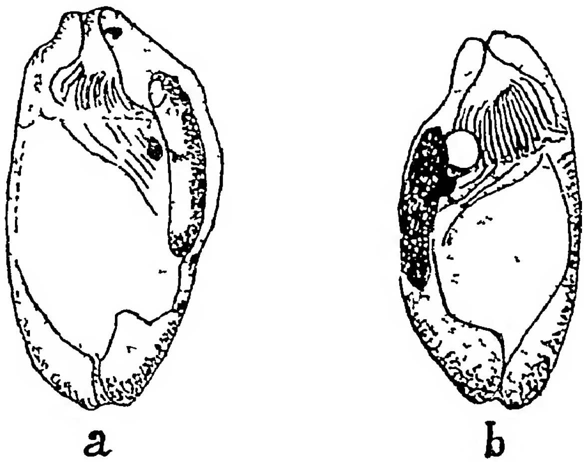


Fig 147 —*Entodinium elongatum* Dogiel *a*, left view, *b*, right view (After Dogiel)

Remarks —This species is very similar to *E nanellum*, but larger in dimensions, and the endoplasmic sack is relatively clearer

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

"LATERALE" GROUP —This group is distinguished principally by the location of the contractile vacuole in the middle of the left lateral surface, by a conspicuous lateral flattening, and the short, stout, almost rectangular proportions of the body in side view *E laterale* and *E rectangulatum* belong to this group

180 **Entodinium laterale** Kofoid & MacLennan (Pl IV, fig 16)

†*Entodinium laterale*, Kofoid & MacLennan, 1930, pp 518–19, pl lii fig 16, fig L, 1, 2, Das Gupta, 1935, p 163

Body short and fairly broad, truncated ellipsoid in lateral outline, length 1 05–1 55 times the dorso-ventral diameter, laterally compressed Dorsal and ventral surfaces both

convex, the dorsal more so than the ventral The broad posterior part of the body terminates in three spines, the dorsal spine is long, thin and flattened laterally, left ventral spine fleshy, right ventral spine a small triangular flap The broad oral area tipped ventrally at a slight angle Endoplasmic sack a laterally compressed cylinder, ending anteriorly just behind the oral apparatus and posteriorly just above the base of the spines Rectum slit-like, opening by a small oval anus Contractile vacuole located in the middle of the left side just opposite the œsophagus Macronucleus a broad wedge-shaped body, two to three times as long as wide, broader anteriorly, located along the dorsal mid-line Micronucleus small, spherical, on the mid-region of the left ventral side of the macronucleus

Dimensions —Length 19–28 μ

Feeds on Flagellates, amœbæ and plant débris

Remarks —The caudal spination of this species resembles that of *E caudatum* Dogiel The laterally flattened dorsal spine, the triangular right ventral spine and the rounded left ventral spine are present in both species The contractile vacuole, however, lies at the left of the anterior end of the macronucleus in *E caudatum* and in the middle of the left side of the body in *E laterale*

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, rumen of *Capra hircus* Linn BENGAL, Calcutta

181 **Entodinium rectangulatum** Kofoid & MacLennan. (Pl IV, fig 19)

†*Entodinium rectangulatum*, Kofoid & MacLennan, 1930, pp 519–21, pl lii, fig 19, fig L, 3, 4, Das Gupta, 1935, p 163

Body stout and heavy, length 1 07–1 48 times the dorso-ventral diameter, laterally compressed Dorsal and ventral surfaces equally convex, lateral surfaces almost flat Posterior end of the body truncated, with three caudal spines, dorsal spine flattened laterally, left ventral spine fleshy, ventral and right side of the body continued posteriorly in a flange-like right ventral spine occupying one-third of the circumference of the body The broad, shallow oral area set at right angles to the main axis, or slightly tipped ventrally Endoplasmic sack a laterally compressed cylinder Rectum slit-like, opening by a small oval anus Contractile vacuole in the middle of the left side just opposite the œsophagus Macronucleus broad, wedge-shaped, two to four times as long as wide, broader at the anterior end, and located along the

dorsal mid-line Micronucleus small, ovoidal, on the mid region of the left ventral side of the macronucleus

Dimensions —Length 29–45 μ

Feeds on Flagellates, Bacteria, amœbæ and plant débris

Remarks —The specimens from *Capra hircus* differ from the description given above in their dimensions, measuring 40–50 μ in length and 25–30 μ in dorso-ventral diameter The micronucleus is placed near the anterior end instead of near the middle of the macronucleus

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, rumen of *Capra hircus* Linn BENGAL, Calcutta

UNALLOCATED SPECIES —The remaining species of *Entodinium* do not show any close relationships with one another, and cannot be arranged in groups

182 **Entodinium anteronucleatum** forma **læve** Dogiel (Fig 148, *a*)

Entodinium anteronucleatum forma *læve*, Dogiel, 1927, pp 49–50, fig 14

†*Entodinium læve*, Das Gupta, 1935, p 162

Body elongated oval, usually slightly compressed laterally, with the posterior end rounded Endoplasmic sack usually

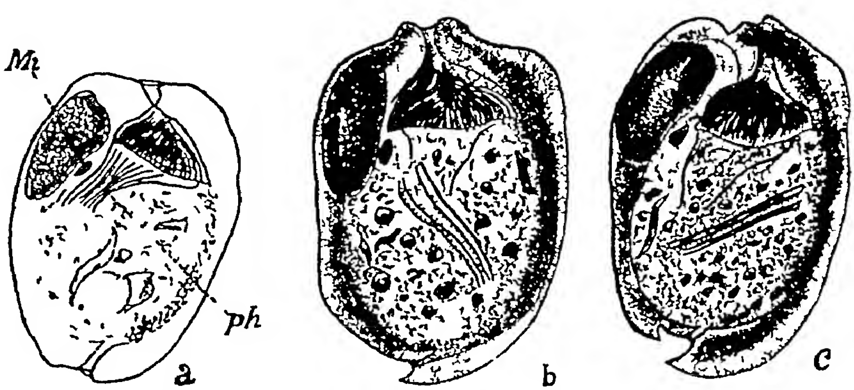


Fig 148 —*Entodinium anteronucleatum* Dogiel *a*, forma *læve*, *b*, forma *monolobum*, *c*, forma *dilobum* *Mi*, micronucleus, *ph*, œsophagus (After Dogiel)

filled with food particles, consisting of chlorophyll granules, shreds of moss, etc Macronucleus short and massive, is situated at some distance from the anterior end, and does not extend beyond the middle of the body Micronucleus

oval and situated ventral to the posterior part of the macronucleus

Dimensions —Length 51–80 μ, breadth 39–49 μ, ratio of length to breadth 1 45

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta.

183 **Entodinium anteronucleatum** forma **monolobum** Dogiel (Fig 148, *b*)

Entodinium anteronucleatum forma *monolobum*, Dogiel, 1927, p 50, fig 15
†*Entodinium monolobum*, Das Gupta, 1935, p 161

General organization as in *E anteronucleatum* forma *læve* except that the body is provided with a very short ventral lobe at the posterior end The lobe is pre-anal and is bent dorsalwards in a hook-like manner

Dimensions —Length 52–82 μ, breadth 39–50 μ, ratio of length to breadth 1 45

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta.

184 **Entodinium anteronucleatum** forma **dilobum** Dogiel (Fig 148, *c*)

Entodinium anteronucleatum forma *dilobum*, Dogiel 1927, pp 50–51, fig 16
†*Entodinium anteronucleatum*, Das Gupta, 1935, pp 161–2

General organization as in *E anteronucleatum* forma *monolobum* except that the posterior end of the body is provided with two lobes The ventral pre-anal lobe is more prominent, and the dorsal lobe is only slightly developed, sometimes so slightly as to be scarcely recognizable

Dimensions as in forma *monolobum*

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

185 **Entodinium bimastus** Dogiel (Pl II, fig 10)

Entodinium bimastus, Dogiel, 1927, pp 55–6, fig 21, *a–c*
†*Entodinium bimastus*, Kofoid & MacLennan, 1930, pp 528–30, pl 1, fig 10, fig O, 3, 4

Body subspherical, length 1 00–1 33 times the dorso-ventral diameter, flattened laterally Oral area relatively small, with deep furrows but rather small lips Posterior part of the body tapers rapidly to form a broad, roughly rectangular caudal lobe, distinctly divided into a dorsal and ventral half by the rectum Contractile vacuole large, to the left of the anterior end of the macronucleus Macronucleus flattened, wedge-shaped, broader anteriorly, four to

seven times as long as thick, closely following the curve of the body along the dorsal mid-line Micronucleus on the left ventral edge of the middle part of the macronucleus

Dimensions —Length 30–40 μ

Feeds on Bacteria and plant débris

Remarks —The subspherical body and broad rectangular caudal lobe serve to distinguish this species from all others of this genus

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

186 **Entodinium brevispinum** Kofoid & MacLennan (Pl IV, fig 18)

†*Entodinium brevispinum*, Kofoid & MacLennan, 1930, pp 521–2, pl lii, fig 18, fig M, 3–4

Body small and oval, length 1 50–2 00 times the dorso-ventral diameter, laterally compressed, and with dorso ventral diameter greatest near anterior end Dorsal and ventral surfaces convex, ventral spine small, parallel to main axis Oral area relatively large and tipped ventrally Endoplasmic sack with well defined boundary layer Rectum small, cylindrical, with a small circular or oval anus Contractile vacuole lies to the left of the macronucleus slightly behind its anterior end Macronucleus broad, wedge-shaped, two to four times as long as wide, from one-half to two-thirds of the length of the body, along the anterior part of the dorsal mid-line Micronucleus small, spherical, on the left ventral surface of the anterior third of the macronucleus

Dimensions —Length 24–30 μ

Feeds on Bacteria, Flagellates and small plant débris

Remarks —This species is similar in proportion, size, general appearance, and in the possession of a wedge-shaped macronucleus to *E laterospinum* and *E nanellum* The shapes of the surfaces and the places of greatest curvature are, however, markedly different in each case, and they are, therefore, not considered to constitute a natural species group

Habitat.—Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

187 **Entodinium caudatum** Stein (Fig 149)

Entodinium caudatum, Stein, 1858, p 70, Kent, 1880–2, p 654, Butschli, 1889, pl lxxii, fig 10, *a*, *b*, Dogiel, 1927, pp 61–2, fig 28, *a*, *b*

†*Entodinium caudatum*, Das Gupta, 1935, p 162

Body oval, with three differently formed processes arising from the posterior end The longest of these processes is dorsal and is an elongated, laterally flattened spine, which

is spirally curved towards the dorsal side The length of this process varies within wide limits The other two processes are pre-anal and lobe-like The right lobe is triangular, with its pointed end directed backwards and to the left The left lobe is not so broad and is more rounded than the right Contractile vacuole to the left of the anterior end of the

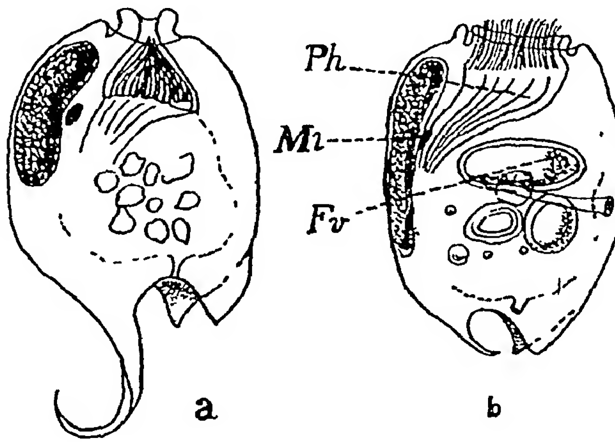


Fig 149 —*Entodinium caudatum* Stein *a*, with normal, *b*, with weakly developed dorsal spine *Fv*, food vacuole, *Mi*, micronucleus, *Ph*, œsophagus (After Dogiel)

macronucleus Macronucleus sausage-shaped, fitting closely against the dorsal margin of the body Micronucleus lies about the middle of the macronucleus

Dimensions —Length 35–50 μ, breadth 25–38 μ (after Dogiel), length 70–90 μ, breadth 30–50 μ (after Eberlein)

Feeds on vegetable particles and Bacteria

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

188 **Entodinium chatterjeei** Das-Gupta (Fig 150)

†*Entodinium chatterjeei*, Das Gupta, 1935, p 165, fig 6

Body elongated oval, broad anteriorly and gradually tapering towards the posterior end The posterior end is rounded and there is no process The ventral side is slightly concave or flattened Contractile vacuole situated near the anterior end of the body Macronucleus ovoidal to spherical in shape and situated in the middle of the dorsal side Micronucleus oval and situated towards the inner anterior end of the macronucleus

Dimensions —Length 26–35 μ, breadth 15–18 μ

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

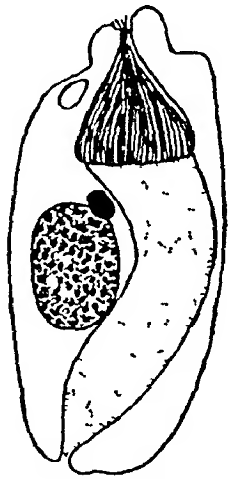


Fig 150 —*Entodinium chatterjeei* Das Gupta (After Das Gupta)

189 Entodinium contractum Kofoid & Christenson (Pl X, fig 1)

†*Entodinium contractum*, Kofoid & Christenson, 1934, pp 348–9 pl xxv, fig 4, fig A, 9, 10

Body pyriform in lateral outline and elongated, length 1 39–1 66 times the dorso-ventral diameter Dorsal and ventral surfaces smoothly convex in anterior two-thirds of the body, levelling out gradually in posterior third , posterior end of the body smoothly rounded Oral region broad, occupying the anterior face Cytostome tilted slightly ventrally and to the left Œsophagus shows an elongated bundle of fibrils and extends backwards and dorsalwards to the right of the middle of the macronucleus Endoplasmic sack spacious, with well-defined boundary layer Rectum very short, with a relatively large funnel-shaped anus opening to the left of the posterior extremity Contractile vacuole against the dorsal surface to the left of the anterior end of the macronucleus Macronucleus a curved, club-shaped rod, broader and deeper in the anterior half, lying directly along the mid-dorsal line and extending from the base of the outer adoral to the posterior fourth of the body Micronucleus small, ovoid to subspherical, lying beneath the left margin of the macronucleus, one-fourth the distance from its anterior end

Dimensions —Length 39–46 μ

Feeds on Bacteria and small Flagellates

Remarks —*E contractum* is similar to *E bimastus* Dogiel in general body form, shape of macronucleus and type of œsophagus, but differs in the posterior end of the body being

regularly tapered, and never drawn in to form a broad rectangular lobe as in the latter species

Habitat—Stomach of *Bos gaurus* H Smith Mulehole, Mysore

190 **Entodinium ekendræ** Das-Gupta (Fig 151)

†*Entodinium ekendræ*, Das Gupta, 1935, pp 163–4, fig 4, *a*, *b*

Body broadly oval, with three differently formed processes from the posterior end, one of these, arising from the right side, is a long spine, 18–20 μ in length, the other two arise from the left side, are smaller and lobe-like Dorsal side convex and ventral side flat Endoplasmic sack clear

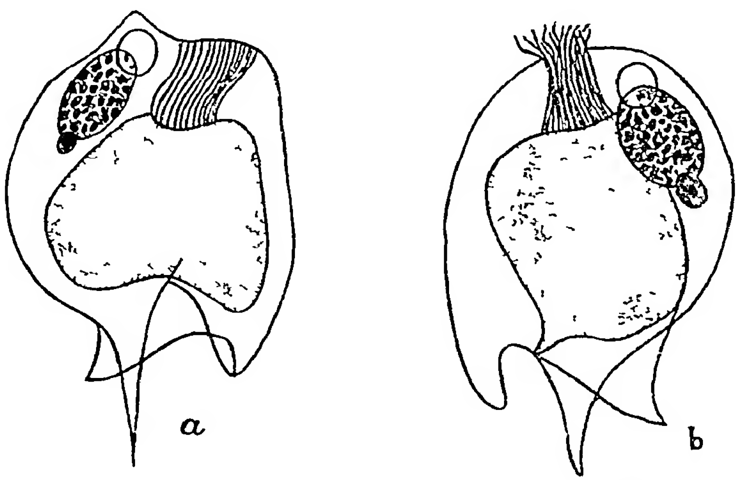


Fig 151 —*Entodinium ekendræ* Das Gupta *a*, right view, *b*, left view (After Das Gupta)

Contractile vacuole close to the anterior end of the macronucleus Macronucleus broadly oval, situated near the anterior end of the body, and never reaching beyond its middle Micronucleus oval, at the posterior end of the macronucleus

Dimensions—Length 30–35 μ, breadth 28–30 μ

Habitat—Rumen of *Capra hircus* Linn BENGAL, Calcutta

191 **Entodinium furca** forma **dilobum** Dogiel (Fig 152)

Entodinium furca, da Cunha, 1914, p 65, pl vii, fig 4
Entodinium furca forma *dilobum*, Dogiel, 1927, p 57, fig 23
†*Entodinium dilobum*, Das Gupta, 1935, p 161

Body elongated oval, not narrowing posteriorly, and broadest at the level of the posterior third of the body The

two posterior processes are in the form of laterally flattened lobes which are convex along their outer margins and concave along the inner Ciliary apparatus and the endoplasmic sack do not present any characteristic feature Macro nucleus sausage-shaped, extends about two-thirds the length of the dorsal margin of the body, and is not closely fitting the dorsal surface Micronucleus lies somewhat anterior to the middle of the macronucleus

Dimensions —Length 42–55 μ, breadth 28–36 μ, ratio of length to breadth 1 6

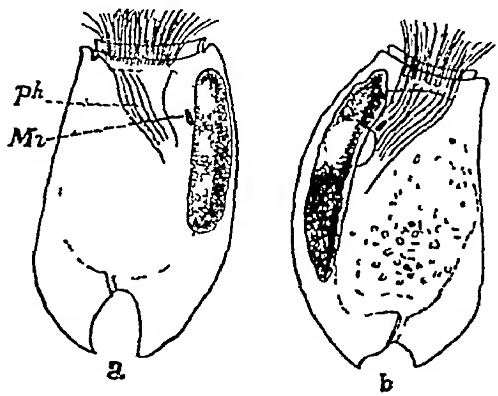


Fig 152 —*Entodinium furca* forma *dilobum* Dogiel *a*, left view, *b*, right view *Mi*, micronucleus, *ph*, œsophagus (After Dogiel)

Remarks —In the specimens from *Capra hircus* the two posterior lobes are slightly curved towards the middle and not so wide apart as in Dogiel's figure, reproduced above The macronucleus is elongated (sometimes ovoidal) and extends slightly beyond the middle of the body

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

192 **Entodinium gibberosum** Kofoid & MacLennan (Pl IV, fig 20)

†*Entodinium gibberosum*, Kofoid & MacLennan, 1930, pp 530–1, pl lii, fig 20, fig P, 3, 4

Body pyriform in a dorsal view, length 1 13–1 72 times the dorso-ventral diameter, smoothly rounded anteriorly, and tapering posteriorly to terminate in two heavy sharp-pointed caudal spines, one dorsal and one ventral Dorsal surface strongly convex, nearly a semicircle, giving a humpbacked appearance Cytostome located ventrally in the centre of the anterior margin, at the apex of a low, broad, conical oral chamber containing the retracted membranelles. Endoplasmic sack marked by a thin indistinct boundary layer Rectum a thin-walled cylinder, flattened dorso-ventrally,

opening by a small elliptical anus Contractile vacuole directly to the left of the anterior tip of the macronucleus Macronucleus long, band-like, five to seven times as long as thick, with a deep notch in the anterior end, extending along the middle three-quarters of the dorsal mid-line Micronucleus small, ellipsoidal, lying on the left ventral edge of the anterior quarter of the macronucleus

Dimensions —Length 38–51 μ

Feeds on Bacteria and small Flagellates

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

193 **Entodinium indicum** Kofoid & MacLennan (Pl I, fig 4)

†*Entodinium indicum*, Kofoid & MacLennan, 1930, pp 533–5, pl xlix, fig 4, fig P, 1 2, Kofoid & Christenson, 1934, p 351, pl xxv, fig 2, fig A, 7, 8

Body oblong in lateral outline, length 1 13–1 56 times the dorso-ventral diameter, laterally compressed, tapered anteriorly toward the contracted oral opening, terminating posteriorly in three long triangular spines—one dorsal, one ventral, and one large spine on the left side Dorsal and ventral surfaces straight Oral area inclined dorsally, cytostome a broad slit opening into the conical oral cavity containing the retracted membranelles Endoplasmic sack with very indistinct boundary layer Rectum a small tube in the base of the left spine, opening by a long narrow slit-like anus on the inner surface of the spine Contractile vacuole close against the left side of the anterior tip of the macronucleus Macronucleus wedge-shaped, dorso-ventrally compressed, three to six times as long as thick, situated in the dorsal mid-line Micronucleus laterally compressed, lying in a small depression in the middle of the left side of the macronucleus

Dimensions —Length 25–40 μ

Feeds on Bacteria and small Flagellates

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

194 **Entodinium laterospinum** Kofoid & MacLennan (Pl I, fig 3)

†*Entodinium laterospinum*, Kofoid & MacLennan, 1930, pp 523 4, pl xlix, fig 3, fig M, 1, 2

Body small and wedge-like, with the anterior end larger than the posterior Dorsal surface strongly convex, with the greatest curvature in the anterior half Ventral surface flat or slightly concave Lateral surfaces convex, with the greatest curvature in the front part A curved ventral spine

pointing dorsally and to the right Oral area relatively small, but the outer adoral furrow is deep and the inner adoral lip well developed The oral area is tipped ventrally Endoplasmic sack bounded by a weak boundary layer Rectum nearly parallel to the main axis and opening by a small elliptical anus Contractile vacuole on the left of the macronucleus, near its anterior end Macronucleus wedge-shaped, broader at the anterior end, and extending up to two-thirds of the length of the body in the dorsal mid-line

Dimensions —Length 25–32 μ

Feeds on Bacteria, small Flagellates and plant débris

Remarks —The wedge-shaped body and the deflection of the ventral spine from the direction of the main axis of the body distinctly separate this species from *E brevispinum*

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore

195 **Entodinium nanellum** Dogiel (Pl II, fig 8)

Entodinium nanellum, Dogiel, 1922, pp 96–7, fig 1, 1925 *a*, pp 117–18, 141, fig 1, *a–c*, 1925 *d*, p 46, 1927, p 40, fig 2, Fantham, 1926, p 566, fig 1

†*Entodinium nanellum*, Kofoid & MacLennan, 1930, pp 524–5, pl 1, fig 8, fig N, 1, 2, Kofoid & Christenson, 1934, p 352, Das Gupta, 1935, p 161

Entodinium nanellum, Wertheim, 1935, pp 228–9, fig 3

Body small and ovoid, length 1 50–2 00 times the dorso ventral diameter, widest in the anterior half, laterally compressed, posterior end smoothly rounded Dorsal and ventral surfaces convex, dorsal more convex in the anterior half and the ventral more convex in the posterior half In the lateral surfaces the greatest curvature in the anterior half Oral area inclined ventrally Endoplasmic sack with thin but distinct boundary layer Rectum a thin-walled cylinder, with a small elliptical anus opening at the extreme posterior end of the body Contractile vacuole to the left of the anterior end of the macronucleus Macronucleus thin, wedge-shaped, broader anteriorly, and four to seven times as long as thick, lying along the dorsal mid-line Micronucleus small, ellipsoidal, located on the left ventral margin of the anterior third of the macronucleus

Dimensions —Length 20–35 μ, breadth 10–18 μ

Feeds on Bacteria and small Flagellates

Remarks —Specimens from *Bos gaurus* were relatively stouter than those from *Bos indicus* In specimens from *Capra hircus* the sausage-shaped nucleus is often seen to lie towards the posterior end of the dorsal side

Wertheim (1935) has more clearly defined this species and added some useful diagnostic characters, differentiating this species from *E simplex* and *E dubardi dubardi*

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore, rumen of *Capra hircus* Linn BENGAL, Calcutta

196 **Entodinium ovale** Jameson (Fig. 153)

†*Entodinium ovalis*, Jameson, 1925, pp 407–8, figs A, B.
Entodinium ovale, Dogiel, 1927, p 67, fig 34

Body small, not dorso-ventrally flattened, the outline rounded oval when looked at from either end Posterior end bluntly rounded and composed of ectoplasm only A short,

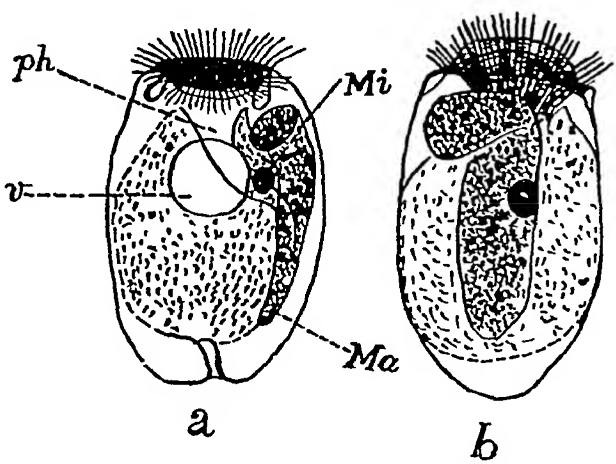


Fig 153 —*Entodinium ovale* Jameson *a*, lateral view, *b*, dorsal view *Ma*, macronucleus, *Mi*, micronucleus, *ph*, œsophagus, *v*, vacuole (From Dogiel, after Jameson)

nearly vertical anal canal runs through this into the endoplasm Anterior end truncated, but only slightly obliquely, and when the wide cytostome is contracted the anterior end is markedly rounded This rounding is caused by the lips, which close the cytostome, being very stoutly built, so that when they come together they form a broad dome-shaped prominence at the anterior end Œsophagus long and curved to the left and dorsally Contractile vacuole on the ventral side of the body towards the middle in the anterior half Macronucleus very large, being both long and broad, is actually longer than the body, so that it is bent at the anterior end into a right-angled hook Micronucleus round or oval, situated as a rule to the inner side of the macronucleus and towards its anterior end

Dimensions—Length 20–40 μ, breadth 12–20 μ, the thickness being rather less, 10–18 μ

Remarks—The species was named *ovale* as the form has a characteristically oval outline when viewed from either side

Habitat—In the stomach of *Tragulus meminna* Milne-Edwards (mouse-deer) Ceylon The material was collected by Dobell (1910)

197 **Entodinium ovinum** Dogiel (Fig 154)

Entodinium ovinum, Dogiel, 1927, pp 44–5, fig 8
†*Entodinium ovinum*, Das Gupta, 1935, p 160

Body very regularly oval, with somewhat truncated anterior end and rounded posterior end Ciliary apparatus and endoplasmic sack do not present any characteristic feature The latter contains numerous but never large food-particles Contractile vacuole large and situated to the left of the anterior

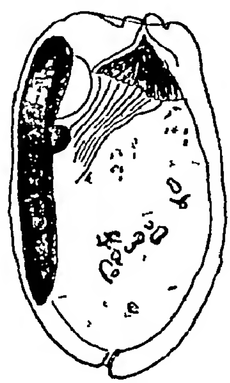


Fig 154—*Entodinium ovinum* Dogiel (After Dogiel)

end of the macronucleus Macronucleus sausage shaped, beginning near the anterior end of the body and extending along the dorsal surface up to the posterior third of the body Micronucleus lies about the middle of the macronucleus

Dimensions—Length 53–69 μ, breadth 32–41 μ, ratio of length to breadth 1 7

Remarks—The specimens from *Capra hircus* were considerably smaller, measuring 45–50 μ in length and 18–21 μ in breadth but it is doubtful if they were correctly identified. Both the length and the breadth are considerably smaller than the dimensions as recorded by Dogiel, and the ratio of length to breadth works out at 2 5 as compared with 1 7 as recorded by Dogiel Further, according to Dogiel *E ovinum* was found in wild sheep and never in any domestic animal

Habitat—Rumen of *Capra hircus* Linn BENGAL, Calcutta

198 **Entodinium ovoideum** Kofoid & MacLennan (Pl III, fig 11)

†*Entodinium ovoideum*, Kofoid & MacLennan, 1930, pp 526–7, pl li, fig 11, fig N, 3, 4

Body ovoidal, length 1 42–2 10 times the dorso-ventral diameter, with the greatest diameter in the posterior half Anterior end truncated, posterior end smoothly rounded, with no indication of a ventral lobe Oral area relatively small, with the outer adoral furrow shallow and the inner adoral lips only weakly developed Endoplasmic sack bounded by a fairly distinct boundary layer Rectum a wide thin-walled slit, with a transverse slit-like anus on the posterior end of the body Contractile vacuole to the left of the macronucleus at its anterior end Macronucleus long, slightly wedge-shaped, wider anteriorly, extending along the anterior two-thirds to three-fourths of the length of the body in the dorsal mid-line Micronucleus small, ellipsoidal, on the left ventral side of the anterior third of the macronucleus

Dimensions —Length 30–50 μ

Feeds on Bacteria, small Flagellates and plant débris

Remarks —This species resembles *E laterospinum* in its smooth contours, shape of macronucleus, lack of posterior projections, and a weak dorso-ventrally compressed rectum It is very similar in proportions and structure to *E ovinum* Dogiel, and the two can be placed in the same species-group

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

199 **Entodinium ovoido-nucleatum** Das-Gupta (Fig 155)

†*Entodinium ovoido nucleatum*, Das Gupta, 1935, pp 162–3, fig 3

Body oval, with three differently formed processes arising from the posterior end The longest one of these is dorsal, 28–30 μ in length, runs straight backwards and tapers to a point, the other two processes are pre-anal and lobe-like The right lobe is triangular, with its pointed end slightly curved dorsalwards The left lobe is smaller and more sharply pointed Dorsal side slightly convex, ventral almost straight and flattened Contractile vacuole situated on the outer anterior side of the macronucleus Macronucleus ovoid and does not extend beyond the middle of the dorsal side of the body Micronucleus also ovoid and situated close to the inner posterior side of the macronucleus

Dimensions —Length 25–30 μ, breadth 22–24 μ

Remarks —The species resembles *E caudatum* very closely, but differs in the dorsal spine being not curved, in the form

and position of the macronucleus and in the position of the contractile vacuole

Habitat.—Rumen of *Capra hircus* Linn. BENGAL, Calcutta

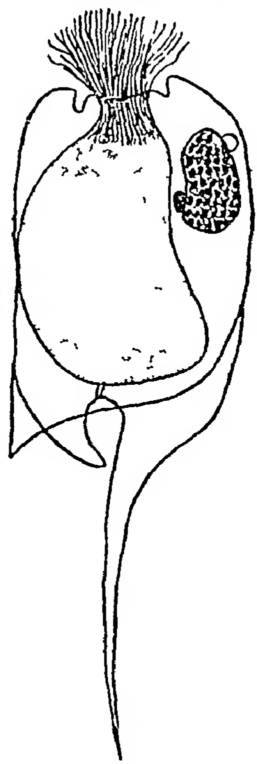


Fig 155.—*Entodinium ovoido nucleatum* Das Gupta (After Das Gupta.)

200 **Entodinium rhomboideum** Kofoid & MacLennan (Pl II, fig 7.)

†*Entodinium rhomboideum*, Kofoid & MacLennan, 1930, pp 527–8, pl 1, fig 7, fig O, 1, 2

Body rhomboid, comparatively long, length 1 40–1 73 times the dorso-ventral diameter, flattened laterally The greatest diameter in the middle of the body, from that level the body tapers toward both anterior and posterior ends Anterior end truncated to form the very narrow oral area Posterior end terminates in a large smooth ventral lobe Endoplasmic sack with a thin boundary layer Rectum thin-walled, cylindrical, with a small oval anus at the base of the ventral lobe Contractile vacuole at the left of the macronucleus just behind the level of its broad anterior end Macro-

nucleus thin, wedge-shaped, broader anteriorly, and extending one-half to two-thirds the length of the body, on the anterior part of the dorsal mid-line Micronucleus small, ovoid, on the left ventral edge of the middle third of the macronucleus

Dimensions —Length 30–47 μ

Feeds on Flagellates, Bacteria and amœbæ

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

201 **Entodinium setnai** Das-Gupta (Fig 156)

†*Entodinium setnai*, Das Gupta, 1935, pp 164–5, fig 5, *a*, *b*

Body oval, anterior end broader than the posterior Dorsal side convex anteriorly and ends in a blunt lobe posteriorly

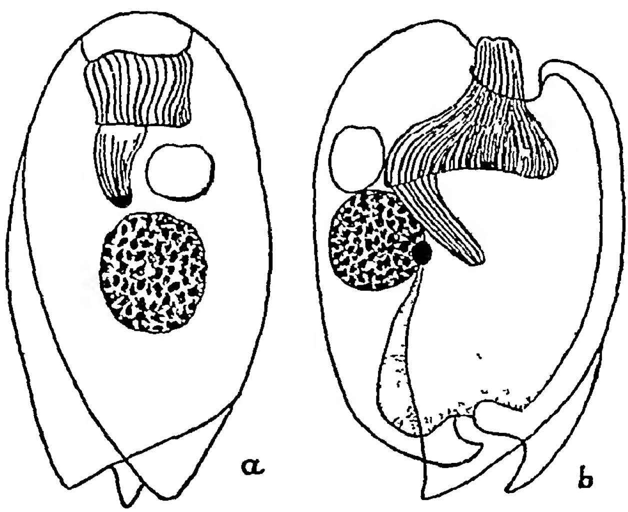


Fig 156 —*Entodinium setnai* Das Gupta *a*, dorsal view, *b*, view from the right side (After Das Gupta)

Ventral side more or less straight and terminating in two small pointed lobes, the right lobe has a broad base and the left lobe is more pointed than the right Endoplasmic sack is clear Contractile vacuole situated anterior to the macronucleus Macronucleus spherical and situated in the middle of the dorsal side

Dimensions —Length 50–60 μ, breadth 26–30 μ

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

202 Entodinium simplex Dogiel (Fig 157)

Entodinium simplex, Dogiel, 1925 *d*, 1927, pp 40–1, figs 3, 4, Wertheim, 1935, pp 238–9, fig 4
†*Entodinium simplex*, Das Gupta, 1935, p 160

Body elongated oval, unarmed, with rounded posterior end Adoral membranelle zone, endoplasmic sack and anal tube do not present any characteristic feature Contractile vacuole situated to the left of the anterior end of the macronucleus Macronucleus band-shaped, closely applied against the dorsal surface of the body, and confined to its anterior two-thirds Micronucleus small, oval, usually close to the middle of the macronucleus

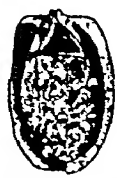


Fig 157 —*Entodinium simplex* Dogiel (After Dogiel)

Dimensions —Length 38–50 μ, breadth 21–29 μ, ratio of length to breadth 1 7–1 74

Feeds on Bacteria

Remarks —In the specimens from *Capra hircus* the lateral sides are flattened and the macronucleus scarcely extends up to the posteroir half of the dorsal side

Wertheim (1935) has more clearly defined the species and added some diagnostic characters, differentiating this species from *E nanellum* and *E dubardi dubardi*

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

203 Entodinium tricostatum Kofoid & MacLennan (Pl 1, fig 5)

†*Entodinium tricostatum*, Kofoid & MacLennan, 1930, pp 532–3, pl xlix, fig 5, fig Q

Body short, broadly ellipsoid, length 0 88–1 10 times the dorso-ventral diameter, with three prominent ribs, one dorsal and two ventral, running the length of the body in a weak dextral spiral, the dorsal and the left ventral ribs terminate in the caudal spines, the thin blade-like right ventral rib in the lateral lobe Adoral spiral narrow but relatively deep and strongly developed Endoplasmic sack with a scarcely distinguishable boundary layer Rectum a small inverted cone, opening by a circular anus in the middle of the posterior end of the body Contractile vacuole at the left of the anterior end of the macronucleus in the dorsal rib Macronucleus

very short, stout, narrower anteriorly, variable in shape, lying in the dorsal rib and following its spiral course Micronucleus small, oval, on the left ventral edge of the middle of the macronucleus

Dimensions —Length 22–33 μ

Feeds on Bacteria and small Flagellates

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

Genus **EODINIUM** Kofoid & MacLennan, 1932

Anoplodinium, part, Dogiel, 1927, pp 75–7, figs 37–9
Eodinium, Kofoid & MacLennan, 1932, pp 69–74, pl iv, figs 3, 4, fig B, 1–4, Calkins, 1933, p 513, Kofoid & Christenson, 1934, pp 362–5

Ophryoscolecidæ with dorsal membranelle zone on the same level as the adoral zone No skeletal plates Contractile vacuoles two Macronucleus a straight rod-like body beneath the dorsal surface of the body

Remarks —The genus is composed of a number of species, formerly included in Dogiel's subgenus *Anoplodinium*, which are related to the typical species of that group only by a single character, the lack of skeletal plates The position and shape of the macronucleus clearly separates these forms from the other species of *Anoplodinium* (=*Diplodinium* Schuberg, emend K & M) In addition, the relatively small operculum, simplicity of caudal armature, and weak development of the endoplasmic sack and rectum mark this genus off from *Diplodinium* The range in size is markedly different in the two genera The species of *Eodinium* average 48 μ in length, with a size range of from 32–60 μ, the species of *Diplodinium*, on the other hand, average 100 μ, with a range of from 55–210 μ

The genus *Eodinium* consists of three species included in the "*Posterovesiculatum*" group and two unallocated species

Key to Indian Species

1 (4)	Body with one or more caudal lobes Macronucleus rod-like, with two contractile vacuoles resting in depressions near its two ends	2
2 (3)	With one ventral lobe	*E lobatum* Kof & [MacL , p 310
3 (2)	With one dorsal and one ventral lobe	*E bilobosum* (Dog), [p 310
4 (1)	Body without any caudal lobe Macronucleus short and tapering anteriorly, to right of dorsal mid-line Contractile vacuoles on dorsal mid line, anterior on level with anterior end and posterior some distance behind the level of the posterior end of the macronucleus	*E rectangulatum* Kof [& MacL , p 311

"POSTEROVESICULATUM" GROUP —The macronucleus is long and narrow The anterior vacuole lies close against the left side of its anterior end, the posterior vacuole lies close to or behind the posterior end of the macronucleus

204 **Eodinium bilobosum** (Dogiel) (Pl X, fig 3)

Anoplodinium postcrovesiculatum forma *bilobosum*, Dogiel, 1927, pp 76–7, fig 39, *a*, *b*
Eodinium bilobosum, Kofoid & MacLennan, 1932, p 72
†*Eodinium bilobosum*, Kofoid & Christenson, 1934, pp 362–5, pl xxv, fig 7, fig B, 1, 2

Body relatively stout, 1 22–1 50 dorso-ventral diameters in length, laterally compressed Dorsal surface slightly convex, ventral surface somewhat flattened A small inconspicuous operculum separates the adoral membranelle zone from the smaller dorsal zone, both of which lie on the same transverse level of the body Two caudal lobes present, a smaller dorsal and a larger ventral lying in the same dorso-ventral plane, separated from each other by a deep concavity Oral area tilted ventrally and to the left Œsophagus a long curved structure marked by conspicuous transverse membranelles, giving a ladder-like appearance to it Rectum short and opens to the exterior through an inconspicuous anus, lying at the base of the dorsal surface of the ventral lobe Contractile vacuoles two and subequal, one lies close against the left antero-dorsal surface of the macronucleus and the other behind the posterior end Macronucleus rod-like, nearly uniform in diameter, lying in the dorsal mid-line Micronucleus small, ellipsoidal, and lies in a concavity in the middle of the dorsal surface of the macronucleus

Dimensions —Length 30–60 μ

Feeds on Bacteria and small Flagellates

Remarks —*E bilobosum* is closely related to *E posterovesiculatum* and to *E lobatum* owing to the position of the posterior contractile vacuole being immediately behind the posterior end of the macronucleus

Habitat —In moderate numbers in the stomach of *Bos gaurus* H Smith Mulehole, Mysore

205 **Eodinium lobatum** Kofoid & MacLennan (Pl V, fig 3)

†*Eodinium lobatum*, Kofoid & MacLennan 1932, pp 70–71, pl iv, fig 3, fig B, 1, 2

Body small and narrow, ellipsoid in dorsal view, length 1 51–1 97 times the dorso-ventral diameter laterally compressed

mid-line, but displaying no ventral curvature Micronucleus a small spherical body

Dimensions —Length 35–70 μ

Feeds on Bacteria and small Flagellates

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

Genus DIPLODINIUM Schuberg 1888, emend Crawley emend Dogiel, emend Kofoid & MacLennan

Entodinium, part, Stein, 1858, p 69, 1859 *a*, p 58, 1867, pp 164, 168

Diplodinium, Schuberg, 1888, pp 369, 404, Crawley, part, 1923, pp 395, 400, pl xviii, fig C 2

Metadinium, part, Crawley, 1923, p 403, pl xxviii, fig C, 2

Diplodinium, Wenyon, 1926, pp 1213–14, Calkins, 1926, p 409

Anoplodinium, part, Dogiel, 1927, pp 72–5, 77–105, figs 40–56

Diplodinium, Reichenow, 1929, p 1199, Kofoid & MacLennan, 1932, pp 74–87, pl iv, figs 1, 2, 5, 6, figs B, 5–7, C, D, 1–4, Calkins, 1933, p 513, Kofoid & Christenson, 1934, pp 352–62, Das Gupta, 1935, pp 165–7

Ophryoscolecidæ with dorsal membranelle zone on the same level as the adoral zone No skeletal plates Contractile vacuoles two Macronucleus beneath the middle of the right surface of the body, the anterior third of the dorsal surface of the macronucleus bent ventrally at an angle of 30°–90°

The principal features of structure will be clearly seen from the accompanying diagram of the lateral view of the type-species (fig 158)

Remarks —The genus *Diplodinium*, as restricted by Kofoid and MacLennan, is easily distinguishable from *Eodinium* by the type and position of the macronucleus Further, the operculum is relatively large and prominent, caudal spines are common, and in many cases posesss a complex fibrillar system, the boundary layer is heavy and the rectum is large and well developed, often showing a complex fibrillar structure The species of *Diplodinium* range in size from 55 to 210 μ and average 100 μ, while those of *Eodinium* range from 32 to 60 μ and average only 48 μ

Key to Indian Species

1 (18)	Body without a caudal fan of spines	2
2 (4)	Body with a broad posterior end	3
3	Body with a truncated posterior end, with six large, incurved caudal spines	*D dentatum* (Stein), [p 313
4 (2)	Body with a narrow posterior end	5
5 (6)	Body oval, posterior end rounded, with a long thin ventral spine	*D consors* (Dogiel), [p 320
6 (5)	Posterior end of the body not rounded	7
7 (15)	Posterior half of the body tapering and conical	8

8 (13)	Only one caudal spine	9
9 (10)	Ventral spine thin	*D psittaceum* (Dogiel), p 319
10 (9)	Ventral spine thick	11
11 (12)	Shorter length of body and relatively larger ventral spine Longitudinal cuticular groove along the right surface present	*D monacanthum* (Dogiel), p 316
12 (11)	Longer body and very small ventral spine Longitudinal cuticular groove absent	*D ceylonicum* Kof & Christ, p 315
13 (8)	More than one caudal spine	14
14 *a*	Two caudal spines	*D diacanthum* (Dogiel), p 317
14 *b*	Three caudal spines	*D triacanthum* (Dogiel), p 317
14 *c*	Four caudal spines	*D tetracanthum* (Dogiel), p 318
14 *d*	Five caudal spines	*D pentacanthum* (Dogiel), p 318
14 *e*	Six caudal spines	*D anisacanthum* da Cunha, p 318
15 (7)	Posterior half of the body triangular Longitudinal cuticular line runs along the dorsal edge of the right lateral surface	16
16 (17)	Body broadly oval, 80–180 μ in length, endoplasmic sack extends into the operculum	*D costatum* Dogiel, p 321
17 (16)	Body oval, 53–90 μ, endoplasmic sack does not extend into the operculum	*D minor* (Dogiel), p 322
18 (1)	Body with a fan of caudal spines	19
19 (20)	Left side extends posteriorly, forming a fan with 2 to 7 spines No spines on dorsal surface	*D crista-galli* Dogiel, p 323
20 (19)	Right side extends posteriorly, forming a fan with 5 to 7 spines Two small spines on posterior dorsal surface	*D flabellum* Kof & MacL, p 323

"DENTATUM" GROUP —This group is marked by the posterior end of the body being broad and truncated and the spines being relatively long and heavy.

207 **Diplodinium dentatum** (Stein) Schuberg (Pl V, fig 2, fig 158)

Entodinium dentatum, Stein, 1858, p 70
Diplodinium dentatum, Schuberg, 1888, p 404
Diplodinium denticulatum, Fiorentini, 1889, p 15, pl ii, figs 4, 5
Diplodinium dentatum, Eberlein, 1895, pp 261–2
Diplodinium dentatum var *denticulatum*, Buisson, 1923 *b*, pp 122–3, fig 44
Diplodinium denticulatum forma *denticulatum*, Dogiel, 1925 *c*, pp 611–12, fig 1
Anoplodinium denticulatum forma *denticulatum*, Dogiel, 1927, pp 84–6, fig 44
Diplodinium denticulatum, Becker & Talbot, 1927, p 353, fig 16
†*Diplodinium dentatum*, Kofoid & MacLennan, 1932, pp 75–7, pl iv, fig 2, figs A, B, 5–7

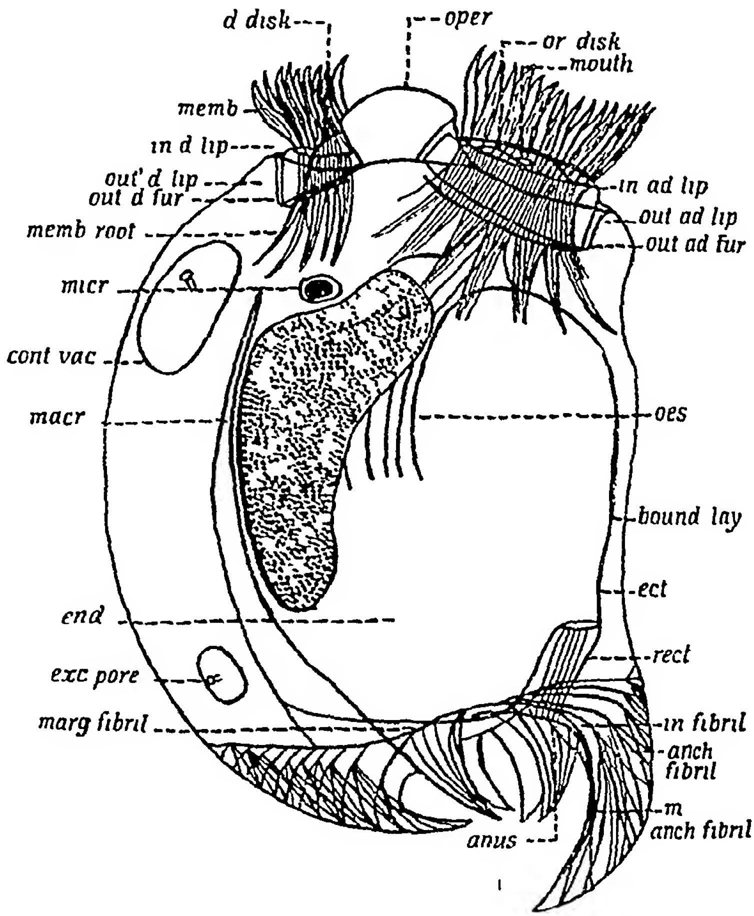


Fig 158 —*Diplodinium dentatum* (Stein) Schuberg Semidiagrammatic lateral view The surface striations are omitted for the sake of clearness ×1000 *anch fibril*, anchoring fibril, *anus*, anus, *bound lay*, boundary layer, *cont vac*, contractile vacuole, *d disk*, dorsal disk, *ect*, ectoplasm, *end*, endoplasm, *exc pore*, excretory pore, *in ad lip*, inner adoral lip, *in d lip*, inner dorsal lip, *in fibril*, inner fibril, *macr*, macronucleus *m anch fibril*, main anchoring fibril, *marg fibril*, marginal fibril, *memb*, membranelle, *memb root*, membranelle root, *micr*, micronucleus, *mouth*, cytostome, *oes*, œsophagus, *oper*, operculum, *or disk*, oral disk, *out ad fur*, outer adoral furrow, *out ad lip*, outer adoral lip, *out d fur*, outer dorsal furrow, *out d lip*, outer dorsal lip, *rect*, rectum (After Kofoid & MacLennan)

Body relatively short and heavy, length 1 20–1 32 times the dorso-ventral diameter, sharply truncated at the anterior and posterior ends, compressed laterally Dorsal surface convex, ventral surface concave, lateral surfaces convex Six large incurved caudal spines, ventral spine longest, dorsal spine a continuation of a heavy longitudinal dorsal rib which arises near the dorsal membranelle zone Oral area of medium size, inclined ventrally at an angle Dorsal membranelle zone relatively short, the inner lip prominent, concealing the small dorsal disk Outer lips of the two membranelle zones continuous, being connected along the right and left sides of the operculum by slight but distinct ridges In a side view the operculum is broad, heavy, and prominent Endoplasmic sack abruptly truncated posteriorly near the bases of the caudal spines, with the boundary membrane relatively thin and difficult to distinguish Rectum short, thin-walled tube, with elliptical anus The two contractile vacuoles lie in the dorsal rib slightly to the left of the mid-line, anterior a short distance behind the dorsal zone, posterior at the level of the posterior end of the macronucleus Macronucleus heavy, rod-like, with its anterior third bent vertically at an angle, variable in length, and lying under the left surface with its dorsal edge along the deep lateral cleft Micronucleus spherical or slightly ellipsoid, lying in a slight depression on the dorsal side of the macronucleus

Dimensions —Length 65–82 μ

Feeds on Bacteria and small particles of cellulose

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

"ANACANTHUM" GROUP —The group is marked by a tapering of the posterior half of the body, giving it a somewhat conical aspect. The development of the spines in different species presents a complete series, ranging from no caudal spine up to six caudal spines

208 **Diplodinium ceylonicum** Kofoid & Christenson (Pl V, fig 5)

†*Diplodinium monacanthum*, Kofoid & MacLennan, 1932, pp 78–80, pl iv, fig 5, fig D, 1, 2
Diplodinium ceylonicum, Kofoid & Christenson, 1934, p 356

Body relatively short and heavy, length 1 52–1 82 times the dorso-ventral diameter, tapering posteriorly, with a small spine, measuring about 6 μ, projecting from the posterior end of the ventral surface Oral area of moderate diameter, lips weakly developed Dorsal zone large and conspicuous

inner dorsal lip well developed Dorsal disk large, projecting above the inner dorsal lip Operculum projects anteriorly for only a short distance Surfaces convex, with the greatest curvature in the posterior third of the body Endoplasmic sack extends posteriorly closely following the contour of the body Rectum a narrow slit, anus just dorsal to the ventral spine Two lenticular contractile vacuoles under the dorsal mid-line, located at each end of the middle third of the body Macronucleus varies from a short stout body, only twice as long as its greatest diameter, to one five or six times as long as its greatest diameter, located under the right lateral surface, with its anterior third sloping ventrally Micronucleus a small ellipsoid body, in a small depression of the dorsal surface of the anterior third of the macronucleus

Dimensions —Length 60–124 μ

Feeds on small particles of plant material

Remarks —This species lacks the cuticular groove, is distinctly and consistently larger, and has a shorter spine than *D monacanthum* (Dogiel)

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

209 **Diplodinium monacanthum** (Dogiel) (Fig 159)

Anoplodinium denticulatum forma *monacanthum*, Dogiel, 1927, p 80, fig 40 *b*

†*Diplodinium monacanthum*, Kofoid & Christenson, 1934, pp 355–6, pl xxvi, fig 9, fig C, 1 2

Body relatively short and heavy, 1 30–1 62 dorso-ventral diameters in length, tapering posteriorly, with a caudal spine measuring 10–17 μ in length There is a longitudinal cuticular groove along the right dorso-lateral surface

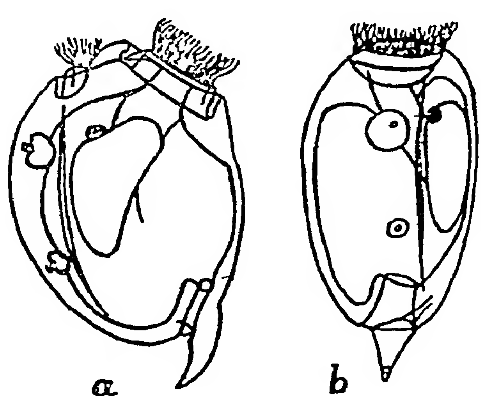


Fig 159 —*Diplodinium monacanthum* (Dogiel) *a*, right lateral view, *b*, dorsal view (After Kofoid & Christenson)

Dimensions—Length 50–68 μ, breadth 30–38 μ

Remarks—Dogiel (1927) recorded this species from domestic cattle in the U S S R, and the measurements given by him are intermediate between those of *D. monacanthum* from the gaur and of *D ceylonicum* from the Indian ox

The species is distinguished from *D ceylonicum* by the shorter length of the body and relatively larger ventral spine, as also by the possession of the longitudinal cuticular groove

Habitat—Stomach of *Bos gaurus* H Smith Mulehole, Mysore

210 **Diplodinium diacanthum** (Dogiel) (Pl X, fig 5)

> *Anoplodinium denticulatum* forma *diacanthum*, Dogiel, 1927, pp 80–1, fig 41, *a, b*
> *Diplodinium diacanthum*, Kofoid & MacLennan, 1932, p 80
> †*Diplodinium diacanthum*, Kofoid & Christenson, 1934, pp 356–9, pl xxvi, fig 10, fig C, 3, 4

Morphologically similar to *D monacanthum* in all respects except spination Two caudal spines present, a ventral one of the same size and position as in *D monacanthum* and a second smaller spine on the right latero-ventral portion of the posterior end or less frequently on the dorsal side Body relatively short and stout, 1 26–1 49 dorso-ventral diameters in length, laterally compressed Dorsal and ventral surfaces are both convex, but the dorsal convexity is greater. Both surfaces taper posteriorly to give the characteristic appearance of the *anacanthum* group A distinct longitudinal cuticular groove along the right dorso-lateral surface as in *D monacanthum*

Dimensions—Length 50–70 μ, breadth 33–42 μ

Remarks—Dogiel (1927) recorded somewhat larger specimens (70–83 μ) from cattle from the U S S R

Habitat—In small numbers in stomach of *Bos gaurus* H Smith Mulehole, Mysore

211 **Diplodinium triacanthum** (Dogiel) (Pl X, fig 6)

> *Anoplodinium denticulatum* forma *triacanthum*, Dogiel, 1927, p 81, fig 42, *a, b*
> *Diplodinium triacanthum*, Kofoid & MacLennan, 1932, p 80
> †*Diplodinium triacanthum*, Kofoid & Christenson, 1934, pp 359–60, pl xxvi, fig 11, fig C, 5, 6

Morphologically similar to *D diacanthum* in all respects except spination. Three caudal spines present, a relatively large ventral spine corresponding to the single spine in *D monacanthum*, a second smaller spine on the latero-ventral edge of the right side, and a third small spine on the dorsal edge

Dimensions—Length 64 μ, breadth 38 μ

Remarks —Dogiel (1927) recorded somewhat larger specimens (70–85 μ) from domestic cattle from the U S S R

Habitat —Only a single specimen was found in *Bos gaurus* H Smith Mulehole, Mysore

212 **Diplodinium tetracanthum** (Dogiel) (Pl X, fig 7)

Anoplodinium denticulatum forma *tetracanthum*, Dogiel, 1927, p 82, fig 42 *c*
Diplodinium tetracanthum, Kofoid & MacLennan, 1932, p 80
†*Diplodinium tetracanthum*, Kofoid & Christenson, 1934, p 360, pl xxvi, fig 12, fig C, 7, 8

Morphologically similar to *D diacanthum* in all respects except spination Four caudal spines are present, three of which are as in *D triacanthum* The fourth spine is added on the latero-dorsal edge of the right side

Dimensions —Length 53–56 μ, breadth 32–33 μ

Remarks —Dogiel (1927) recorded considerably larger (72–83 μ) specimens from domestic cattle from the U S S R

Habitat —Two specimens were found in the stomach of *Bos gaurus* H Smith Mulehole, Mysore

213 **Diplodinium pentacanthum** (Dogiel) (Pl X, fig 8)

Anoplodinium denticulatum forma *pentacanthum*, Dogiel, 1927 p 82, fig 42 *d*
Diplodinium pentacanthum, Kofoid & MacLennan, 1932, p 81
†*Diplodinium pentacanthum*, Kofoid & Christenson, 1934, p 361, pl xxvi, fig 13, fig C, 9, 10

Morphologically similar to *D diacanthum* in all respects except spination There are five caudal spines—four as in *D tetracanthum* and an additional spine added on the left side

Dimensions —Length 50–54 μ, breadth 32–34 μ

Remarks —Dogiel (1927) recorded considerably larger specimens (67–84 μ) from domestic cattle from the U S S R

Habitat —Two specimens were found in the stomach of *Bos gaurus* H Smith Mulehole, Mysore

214 **Diplodinium anisacanthum** da Cunha (Pl X, fig 9)

Diplodinium anisacanthum, da Cunha, 1914, p 64, fig 3, Buisson, 1923 *b*, p 123, fig 44
Metadinium anisacanthum, Crawley, 1923, p 401, Fantham, 1926, p 568
Anoplodinium denticulatum forma *anisacanthum*, Dogiel, 1927, p 83, fig 42 *e*
Diplodinium anisacanthum, Becker & Talbot, 1927, p 356, Kofoid & MacLennan, 1932, p 81
†*Diplodinium anisacanthum*, Kofoid & Christenson, 1934, pp 361–2, pl xxvi, fig 14, fig C, 11, 12, Das-Gupta, 1935, p 166

Morphologically similar to *D diacanthum* except spination

There are six caudal spines—one ventral, one dorsal, and two on each side The spines are as in *D pentacanthum*, with a sixth spine added on the left lateral surface

Dimensions —Length 46–67 μ, breadth 28–37 μ

Remarks —Dogiel (1927) recorded considerably larger specimens (77–86 μ) from domestic cattle from the U S S R

Habitat —In very limited numbers in the stomach of *Bos gaurus* H Smith Mulehole, Mysore, in small numbers in the rumen of *Capra hircus* Linn BENGAL, Calcutta

215 **Diplodinium psittaceum** (Dogiel) (Pl V, fig 1)

Anoplodinium psittaceum, Dogiel, 1927, pp 93–4, fig 48
†*Diplodinium psittaceum*, Kofoid & MacLennan, 1932, pp 81–2, pl iv, fig 1, fig C, 1, 2

Body heavy, rounded, length 1 34–1 61 times the dorso-ventral diameter, compressed laterally Oral area relatively small in diameter, inclined ventrally and to the left Adoral region large, with lips of moderate size Operculum short but relatively broad and conspicuous Dorsal disk also large and conspicuous Surfaces of the body convex, with the greatest curvature in the middle and posterior parts of the body A low narrow rib arises on the posterior half of the ventral mid-line and ends at the anus in a short acute spine A flange arises in the posterior quarter of the dorsal mid-line and disappears near the anus Endoplasmic sack extends posteriorly, closely following the contours of the body, boundary layer distinct Rectum short, dorso-ventrally flattened cylinder, opening by an elliptical anus Contractile vacuoles large, lentoidal, anterior on a level with the macronucleus, posterior in the posterior third of the body Macronucleus a stout rod-like body, from three to six times as long as its largest diameter, with its anterior third bent ventrally, lying under the middle of the right surface of the body Micronucleus ellipsoidal, in a small depression on the dorsal surface of the anterior third of the macronucleus

Dimensions —Length 95–150 μ

Feeds on large pieces of plant material

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

"BUBALIDIS" GROUP —In this group the organisms have a small longitudinal cuticular groove extending a short distance anteriorly from the right border of the anus, and the endoplasmic sack reaches anteriorly into the operculum Sometimes a long thin ventral spine with a narrow base may be present The following species is doubtfully referred to this group

216 **Diplodinium consors (Dogiel)** (Fig 160)

Diplodinium bubalidis forma *consors*, Dogiel, 1925 a, pp 124–6, fig 3 Fantham, 1926, p 567
Anoplodinium bubalidis forma *consors*, Dogiel, 1927, pp 98–9, fig 52
Diplodinium consors, Kofoid & MacLennan, 1932, p 84
†*Diplodinium consors*, Das Gupta, 1935, p 166

Body oval, dorsal and ventral surfaces strongly convex Posterior end of the body is provided with a pre anal sickle shaped spine, which is movably jointed with the body Endo plasmic sack is simple and does not extend anteriorly into the operculum Contractile vacuole lies dorsal to the middle of the macronucleus Macronucleus relatively short and broad and its long axis not parallel with the long axis of the body,

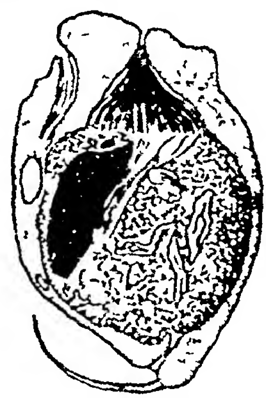


Fig 160 —*Diplodinium consors* (Dogiel) (After Dogiel)

but inclined ventralwards The anterior end of the macro nucleus shows a curved point, and the small elongated micro nucleus lies in the depression

Dimensions —Length 65–108 μ, breadth 35–46 μ, ratio of length to breadth 1 87

Feeds on vegetable particles

Remarks —The species is distinguished from *D bubalidis* by the form of the macronucleus and by the absence of the apical diverticulum of the endoplasmic sack Kofoid and MacLennan (1932) consider it questionable if *D consors* is nearly related to *D bubalidis*

Habitat —Found (in one case only) in the rumen of *Capra hircus* Linn BENGAL, Calcutta

"RANGIFERI" GROUP —This group includes species marked by a distinct longitudinal cuticular line running along the length of the dorsal edge of the right lateral surface The rectum is relatively large and heavy The spines included in this group are relatively short

217 Diplodinium costatum Dogiel (Fig 161.)

Diplodinium costatum forma *major*, Dogiel, 1925 *a*, pp 121–3, fig 2, E
Anoplodinium costatum forma *major*, Dogiel, 1927, pp 102–3, fig 55
Diplodinium costatum, Kofoid & MacLennan, 1932, p 85
†*Diplodinium costatum*, Das-Gupta, 1935, p 167

Body broadly oval, length 1 4 times the dorso-ventral diameter, truncated anteriorly, triangular posteriorly A narrow longitudinal thickening of the cuticle extends along the right dorsal surface from the anterior end to the anus Endoplasmic sack has an anterior diverticulum extending into the operculum Rectum and anus small Contractile vacuoles

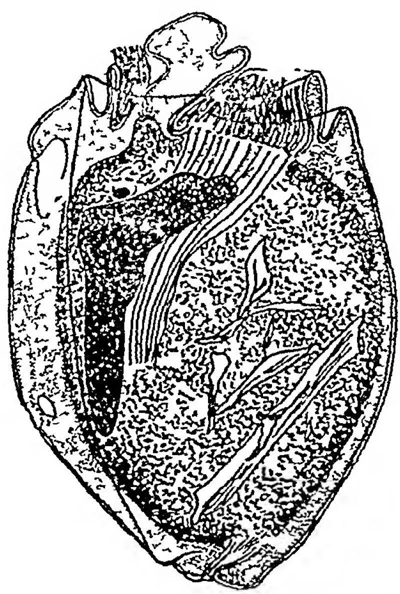


Fig 161 —*Diplodinium costatum* Dogiel (After Dogiel)

two, subequal, lying along the dorsal border, the anterior one somewhat anterior to the macronucleus and the posterior one on a level with its posterior end Macronucleus in the form of a hook, the horizontal limb of which is directed ventralwards Micronucleus lies in a depression on the anterior side of the horizontal limb of the macronucleus

Dimensions —Length 80–180 μ, breadth 55–110 μ

Remarks —Dogiel described *D costatum major* and *D costatum minor* Kofoid and MacLennan (1932), who regard these forms as distinct species, have restricted the name *D costatum* to the form described as *D costatum major* by Dogiel

Habitat —In two cases in the rumen of *Capra hircus* Linn
Bengal, Calcutta

218 **Diplodinium minor** (Dogiel) (Pl X, fig 4)

Diplodinium costatum forma *minor*, Dogiel, 1925 *a*, p 121–3, fig 2 F

Anoplodinium costatum forma *minor*, Dogiel, 1927, pp 103–4, fig 56

Diplodinium minor, Kofoid & MacLennan 1932, p 85

†*Diplodinium minor*, Kofoid & Christenson, 1934, pp 352–5, pl 25, fig 8, fig B, 3, 4

Body oval, truncated anteriorly, relatively stout, length 1 22–1 6 times the dorso-ventral diameter, strongly compressed laterally, and somewhat triangular in lateral view in the posterior third of the body Dorsal zone of membranelles lies at the same transverse level of the body as the adoral zone A narrow, longitudinal, cuticular line extends along the right dorsal surface from the base of outer dorsal furrow to dorsal edge of the anal opening Oral region of moderate size, tilted ventrally and to the left Operculum shallow, projecting a short distance anteriorly Œsophagus inconspicuous, weakly marked by several curved, longitudinal fibrils Endoplasmic sack does not form an anterior diverticulum extending into the operculum Rectum a dorso-ventrally depressed canal opening to exterior through an inconspicuous slit-like anus situated at the posterior end of the body Macronucleus relatively stout, somewhat hatchet-shaped, lying under the right surface of the body, slightly dorsal to the lateral mid-line Micronucleus small, ovoid, lying in a slight concavity on the antero-dorsal surface of the macronucleus Contractile vacuoles two, usually subequal, lying along the dorsal mid-line of the body, the anterior larger at the level of the micronucleus, and the posterior nearly on a level with the posterior end of the macronucleus

Dimensions —Length 53–80μ, dorso-ventral diameter 40–53μ, ratio of length to dorso-ventral diameter 1 22–1 51 (Kofoid & Christenson), length 60–90μ, dorso-ventral diameter 45–51μ, ratio of length to dorso-ventral diameter 1 6 (Dogiel)

Remarks —The species differs from *D costatum* in being smaller in size, and in the endoplasmic sack not extending anteriorly into the operculum Along with *D rangiferi* Dogiel, 1925, and *D dogieli* Kof & MacL, 1932, the four species constitute the natural *rangiferi* group

Habitat —Stomach of *Bos gaurus* H Smith Mulehole, Mysore

"CRISTA-GALLI" GROUP —This group includes species with a roughly triangular lateral outline, truncate anteriorly and tapering posteriorly Rectum relatively long and circular in cross-section

219 **Diplodinium crista-galli** Dogiel (Fig 162)

Diplodinium crista galli, Dogiel, 1927, p 9
Anoplodinium crista galli forma *crista galli*, Dogiel, 1927, pp 91–3, fig 47 *a*, *c–f*
Diplodinium crista galli, Kofoid & MacLennan, 1932, p 86
†*Diplodinium crista galli*, Das Gupta, 1935, p 167

Body triangular in lateral view, the left side extends posteriorly, forming a prominent fan with two to seven spines Endoplasmic sack is full of cellulose particles and chlorophyll granules etc Anal tube is clear and is directed obliquely backwards and dorsalwards Contractile vacuoles, two in number, lie dorsal to the macronucleus, and are dorso-ventrally compressed Macronucleus hatchet-shaped, its anterior limb

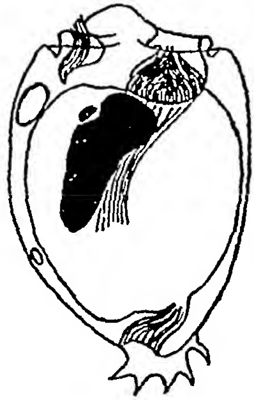


Fig 162 —*Diplodinium crista galli* Dogiel (After Dogiel)

not strongly developed, and directed obliquely forwards and ventralwards Micronucleus lies in a depression on the dorsal side of the macronucleus

Dimensions —Length 77–100 μ, breadth 52–70 μ, ratio of length to breadth 1 45

Habitat —In small numbers in the rumen of *Capra hircus* Linn BENGAL, Calcutta

220 **Diplodinium flabellum** Kofoid & MacLennan (Pl V, fig 6)

†*Diplodinium flabellum*, Kofoid & MacLennan, 1932, pp 86–7, pl iv, fig 6, fig D, 3–8

Body relatively short, length 1 29–1 56 times the dorso-ventral diameter, laterally compressed, roughly triangular in lateral view, tapering rapidly from the mid-region to the

rounded posterior end Right side extends posteriorly, forming a prominent fan with five to seven spines which may be simple, bifurcate, or even trifurcate , two small spines arise on the posterior dorsal surface, one on each side of the mid-line, left simple, right bifurcate Oral area of moderate size, inclined ventrally and to the left Dorsal membranelle zone short, with a heavy inner lip which hides the small dorsal disk Operculum relatively small Endoplasmic sack closely follows the outer contour of the body to the posterior end ; boundary layer strongly developed Rectum narrow, tubular, opening at the posterior end by a circular anus, which lies in the mid-line to the left of the caudal fan Only one relatively large contractile vacuole observed, located under the mid-dorsal surface near to the dorsal zone, second vacuole may be present Macronucleus a heavy rod-like body, with its anterior end usually two to three times the diameter of the posterior end and slightly bent ventrally, lying under the right surface Micronucleus ellipsoidal, in a small depression on the dorsal surface of the anterior third of the macronucleus

Dimensions —Length· 82–118 μ

Feeds on small particles of plant material

Remarks —The species is similar to *D crista-galli* Dogiel in the general shape of the body, shape of the rectum, and in the unique caudal fan of spines, which, however, is formed by an extension of the left side of the body in that species

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor

Genus **EREMOPLASTRON** Kofoid & MacLennan, 1932

Eudiplodinium, part, Dogiel, 1927, pp 104–19, figs 57–66
Eremoplastron, Kofoid & MacLennan, 1932, pp 88–103

Ophryoscolecidæ with two membranelle zones, viz , an adoral, and a dorsal zone lying at the anterior end of the body A single, narrow skeletal plate beneath the right surface Contractile vacuoles two Macronucleus triangular or rod-like, with the anterior end often bent ventrally

Key to Indian Species

1 (2)	Posterior end smoothly rounded, with no ventral lobe or caudal spines	*E rotundum* Kof & [MacL , p 328
2 (1)	Posterior end with one or more lobes or spines	3
3 (4)	Posterior end with a small ventral lobe only	*E bovis* (Dogiel), [p 325
4 (3)	Posterior end with one or two spines	5
5 (6)	With thick dorsal flange and large ventral caudal spine	*E rostratum* (Fioren- [tini), p 327
6 (5)	With two caudal spines	7

7 (8)	Body ellipsoidal in side view, with two short caudal spines	*E brevispinum* Kof & [MacL, p 325
8 (7)	Body rectangular in side view, with two large caudal spines	*E magnodentatum* Kof [& MacL, p 326

221 Eremoplastron bovis (Dogiel) (Pl VI, fig 10)

Eudiplodinium neglectum forma *bovis*, Dogiel, 1927, p 108, fig 58
Anoplodinium neglectum forma *bovis*, Dogiel, 1927, p 244
Diplodinium clevelandi, Becker & Talbot, 1927, pp 356–7, pl ii, fig 20
†*Eremoplastron bovis*, Kofoid & MacLennan, 1932, pp 95–7, pl v, fig 10, fig F, 5, 6

Body ellipsoidal, length 1 44–1 89 times the dorso-ventral diameter, compressed laterally Ventral surface somewhat flattened except in the posterior quarter, dorsal more strongly convex A small, smoothly rounded ventral lobe projects from the ventral half of the posterior end Cytostome relatively small, inclined ventrally and to the left Dorsal membranelle zone small Operculum well developed and conspicuous Narrow skeletal plate extends diagonally under the right surface from the edge of the oral region to the middle of the right side Endoplasmic sack occupies the greater part of the body, boundary layer easily seen Rectum extends from the posterior end of the boundary layer and opens in the middle of the posterior end of the body at the base of the ventral lobe Two contractile vacuoles beneath the surface along the mid-dorsal line, anterior a short distance behind the dorsal membranelle zone and the posterior at the level of the posterior end of the macronucleus Macronucleus elongate, beneath the middle of the right surface, its ventral edge parallel and close to the skeletal plate and its dorsal side convex with a conspicuous indentation in the middle, in which the small ovoidal micronucleus lies

Dimensions —Length 52–100 μ

Feeds on small bits of plant débris

Remarks —*E bovis* shows closest resemblance to *E neglectum*, which is relatively simple in structure and, like this species, possesses a single ventral lobe The operculum in *E bovis* is a great deal smaller than in *E neglectum*

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

222 Eremoplastron brevispinum Kofoid & MacLennan (Pl VI, fig 8)

Eremoplastron brevispinum, Kofoid & MacLennan, 1932, pp 97–8, pl v, fig 8, fig F, 9, 10
†*Eremoplastron brevispinum*, Das Gupta, 1935, p 168

Body ellipsoidal, length 1 54–1 84 times the dorso-ventral

diameter, compressed laterally Dorsal surface convex, ventral surface flat or slightly concave in anterior half, convex in posterior half, lateral surfaces convex Two short broad caudal spines, one dorsal to the anus the other ventral to it and merely a slight prolongation of the ventral lobe Cytostome small, inclined ventrally and to the left Dorsal membranelle zone relatively small Operculum conspicuous Skeletal plate narrow, extending diagonally beneath the right surface from the edge of the oral zone to the middle of the body, anterior end of the plate three or four times wider than the posterior Endoplasmic sack occupies the greater part of the body and posteriorly extends beyond the anterior end of the rectum Rectum wide, slit-like, opening by a narrow elliptical anus lying between the dorsal and ventral spines Two contractile vacuoles lie beneath the dorsal mid-line, anterior at the level of the anterior end of the macronucleus and the posterior just behind the level of the posterior end of the macronucleus Macronucleus beneath the right surface just dorsal to the skeletal plate, its ventral side flat or slightly concave, dorsal surface convex, with a large indentation in its middle, in which a spherical or slightly ellipsoidal micronucleus lies

Dimensions —Length 72–92 μ

Feeds on small bits of plant débris

Remarks —The shape, proportions and structure relate the species closely to *E bovis*, but the presence of two spines shows a small advance in complexity over the single conical lobe of *E bovis*

Habitat —Stomach of *Bos indicus* Linn CEYLON, Colombo, rumen of *Capra hircus* Linn BENGAL, Calcutta

223 **Eremoplastron magnodentatum** Kofoid & MacLennan (Pl VI, fig 9)

†*Eremoplastron magnodentatum*, Kofoid & MacLennan, 1932, pp 100–2, pl v, fig 9, fig F, 11, 12

Body rectangular in side view, length 1 50–1 93 times the dorso-ventral diameter, compressed laterally and ovoidal in dorsal view, with the largest diameter anterior Dorsal surface flat, ventral slightly convex Two large laterally compressed caudal spines give a remarkable pincer-like appearance to the posterior end of the body Oral region inclined ventrally but not inclined toward either side Adoral zone well developed, but the operculum is relatively small Skeletal plate lies beneath the right surface and extends diagonally from the edge of the oral region toward the middle of the body, with its anterior part wider than the posterior Endo-

plasmic sack extends to the posterior end of the body, a part bulges into the base of the dorsal spine and extends beyond the rectum Rectum slit-like, opening by an elliptical anus in the base of the ventral spine Two contractile vacuoles lie beneath the dorsal mid-line, anterior near the level of the micronucleus, posterior near the level of the posterior end of the macronucleus Macronucleus beneath the right surface close against the dorsal edge of the skeletal plate, its ventral surface slightly concave, dorsal surface strongly convex, with a small relatively deep depression in which the ellipsoidal micronucleus lies

Dimensions—Length 58–82 μ

Feeds on small bits of plant débris

Remarks—This species shows a close resemblance to *E dilobum* Dogiel, but differs in the possession of large conspicuous caudal spines instead of true caudal lobes as in that species

Habitat—Stomach of *Bos indicus* Linn MADRAS, Coonoor. CEYLON, Colombo

224 **Eremoplastron rostratum** (Fiorentini) (Pl VI, fig 7, Pl XI, fig 12)

Diplodinium rostratum, Fiorentini, 1889 *a*, pp 16, 24, fig 3, Eberlein, 1895, pp 262–3, pl xviii, fig 18 da Cunha, 1914, pp 62–4

Eudiplodinium rostratum, Dogiel, 1927, pp 118–19, fig 66

Diplodinium helseri, Becker & Talbot, 1927, pp 357–8, pl ii, fig. 11

†*Eremoplastron rostratum*, Kofoid & MacLennan, 1932, pp 91–3, pl v, fig 7, fig F, 1, 2, Kofoid & Christenson, 1934, pp 367–8, pl xxviii, fig 19, fig E, 1–12, Das Gupta, 1935, pp 167–8

Body small but relatively long, length 1 50–2 00 times the dorso-ventral diameter, compressed laterally Dorsal surface convex, ventral surface nearly flat A long caudal spine extends posteriorly from the region between the anus and the ventral surface Posterior third of the dorsal side of the body thin and forms a flange-like projection Oral region relatively large, tipped ventrally and to the left at an angle Dorsal membranelle zone small Operculum relatively small, overhangs and obscures the dorsal membranelle zone Narrow skeletal plate under the right surface, extending from the edge of the oral zone to the middle of the body, anterior end of the plate four to five times as broad as the posterior end Ectoplasm relatively thick, boundary layer thin, endoplasmic sack oval Rectum short, cylindrical, extending dorsalwards from the posterior end of the endoplasmic sack Two contractile vacuoles beneath the dorsal surface, along the mid-line, anterior at the level of the micronucleus, posterior in the

anterior part of the dorsal flange Macronucleus beneath the right surface of the body, parallel and dorsal to the skeletal plate, an elongate body, its ventral side nearly straight and its dorsal surface convex, with a large median indentation in which the small ellipsoidal micronucleus lies

Dimensions — Length 40–52 μ (according to other observers up to 80 μ)

Feeds on small bits of plant débris

Remarks —*E rostratum* is marked off from the other species of the genus by its small size and the presence of the dorsal flange Specimens from *Bos gaurus* were relatively shorter and stouter than those from *B indicus*

Habitat —Stomach of *Bos indicus* Linn CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore, rumen of *Capra hircus* Linn BENGAL, Calcutta

225 **Eremoplastron rotundum** Kofoid & MacLennan (Pl VI, fig 11)

†*Eremoplastron rotundum*, Kofoid & MacLennan, 1932, pp 93–4 pl v, fig 11, fig F, 7, 8

Body relatively short and broadly ovoidal in side view, length 1 33–1 66 times the dorso-ventral diameter, with the largest diameter posterior, compressed laterally, posterior end smoothly rounded, with neither lobe nor spines Oral area of medium size, inclined ventrally and to the left Dorsal zone short but lips well developed Operculum small and relatively inconspicuous Skeletal plate extends diagonally beneath the right surface from the edge of the oral region to the middle of the body, broader anteriorly narrow posteriorly Endoplasmic sack occupies most of the body and follows the surface contours closely, boundary layer distinct Rectum wide and slit-like Anus a narrow slit located in the middle of the posterior end Two contractile vacuoles under the dorsal mid-line at about the levels of the ends of the macronucleus Macronucleus in the middle half of the body adjacent to the dorsal edge of the skeletal plate, its ventral side flat or slightly concave, dorsal side strongly convex, with a shallow median depression Micronucleus small, ovoidal, lying in the depression of the macronucleus

Dimensions —Length 70–95 μ

Feeds on small bits of plant débris

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

Genus **DIPLOPLASTRON** Kofoid & MacLennan, 1932

Eudiplodinium, part, Dogiel, 1927, pp 123–4
Diploplastron, Kofoid & MacLennan, 1932, pp 107–8

Ophryoscolecidæ with dorsal and adoral membranelle zones at the anterior end of the body Two skeletal plates beneath the right surface of the body Contractile vacuoles two, below dorsal surface, separated from the macronucleus Macronucleus narrow, rod-like

Remarks —Though possessing two skeletal plates the genus is more closely related to *Eremoplastron* than to *Metadinium* It differs from the former in possessing two skeletal plates and from the latter in the shape of the macronucleus and in possessing thin cuticle and ectoplasm and small rectum and anus

226 **Diploplastron affine** (Dogiel & Fedorowa) (Fig 163)

Diplodinium affine, Dogiel & Fedorowa, 1925, p 100
Eudiplodinium affine, Dogiel, 1927, pp 123–4, fig 68
Diploplastron affine, Kofoid & MacLennan, 1932, p 108, fig H, 2
†*Diplodinium affine*, Das Gupta, 1935, p 168

Body small and oval, 1 7 dorso-ventral diameters in length Two skeletal plates lie beneath the right surface of the body,

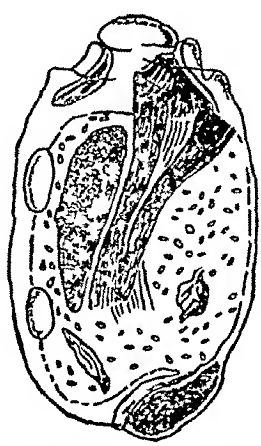


Fig 163 —*Diploplastron affine* (Dogiel & Fedorowa) (After Dogiel)

extending from the edge of the oral area past the middle of the body The anterior ends of the plates are separated, while the posterior parts of the plates come close together but do not fuse Each plate is made up of from five to six rows of prisms Operculum is small Endoplasmic sack extends posteriorly beyond the anterior end of the rectum Rectum

narrow, tubular, with thin walls Anus small and circular Contractile vacuoles two, situated along the dorsal border of the body, apart from the macronucleus, the anterior one in front of the level of the middle of the macronucleus and the posterior behind the level of the posterior end of the macronucleus Macronucleus narrow, sausage-shaped to club-shaped Micronucleus lies in a small depression in the middle of the dorsal margin of the macronucleus

Dimensions —Length 88–120 μ, breadth 47–65 μ, ratio of length to breadth 1 7

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

Genus **EUDIPLODINIUM** Dogiel, 1927, emend Kofoid & MacLennan, 1932

Eudiplodinium, part Dogiel, 1927, pp 119–22, fig 67, *a*, *b*, Kofoid & MacLennan 1932, pp 103–7

Ophryoscolecidæ with two membranelle zones, viz, an adoral zone, and a dorsal zone lying at the anterior end of the body A single, narrow, skeletal plate beneath the right surface Cuticle and ectoplasm thick Two contractile vacuoles with heavy membranes and prominent pores Macronucleus rod-like, with anterior end enlarged to form a hook opening dorsally

227 **Eudiplodinium maggii** (Fiorentini) (Pl VI, fig 12, Pl XI, fig 13)

Diplodinium maggii, Fiorentini, 1889, p 13, pl i, figs 3, 4, Eberlein, 1895, pp 252–6, figs 8, 9, Buisson 1923 *b*, pp 103–5, fig 36

Diplodinium bursa, Schulze, 1924, pp 657, 661, fig 5

†*Diplodinium maggii*, Jameson, 1925, pp 408–9

Diplodinium maggii, Dogiel & Fedorowa, 1925, pp 98, 100, 106, fig 1; Becker & Talbott, 1927, p 353

Diplodinium bursa, Becker & Talbott, 1927, p 354, pl ii, fig 21

Eudiplodinium maggii, Dogiel, 1927, pp 119–22, fig 67, *a*, *b*

†*Eudiplodinium maggii*, Kofoid & MacLennan, 1932, pp 105–7, pl v, fig 12, fig F, 3, 4, Kofoid & Christenson, 1934, pp 368–70, pl xxviii, fig 20, fig F, 1, 2, Das Gupta, 1935, p 168

Body roughly triangular in side view, length 1 33–1 67 times the dorso-ventral diameter, sharply truncated anteriorly and tapering to a smoothly rounded posterior end, flattened laterally, giving a rather narrow elliptical outline in dorsal view Dorsal surface convex, anterior half of ventral surface flat or concave, posterior half convex Oral region relatively small, and inclined ventrally and to the left Dorsal membranelle zone relatively large, operculum relatively small and inconspicuous Skeletal plate lies beneath the right surface

and extends from the oral region dorsally across the middle of the body, its anterior end broad, tapering posteriorly Cuticle forms a distinct layer, ectoplasm thick, boundary layer distinct, clearly marking out the endoplasmic sack Rectum heavy, slit-like, anus opens on the right side of the posterior end Usually two contractile vacuoles lie beneath the dorsal surface near the mid-line, anterior at the level of the micronucleus, posterior at the level of the posterior end of the macronucleus, but the number may be increased to six Macronucleus elongate, rod-like, with the anterior end hooked dorsally, situated beneath the middle of the right surface adjacent to the dorsal border of the skeletal plate Micronucleus ovoidal, lying in the concavity of the hook

Dimensions—Length 104–255 μ

Feeds on relatively large particles of plant material and some of the smaller Ciliates occurring in the same host

Remarks—There has been considerable confusion between *E maggii* and *Diplodinium bursa* owing to the somewhat incomplete descriptions of Fiorentini However, as pointed out by Kofoid and MacLennan, it is clear from his drawings that there is a deep anal groove marking off dorsal and ventral caudal lobes in his *D bursa*, while his *D maggii* has a rather pointed posterior end with no lobes at all

This species was present but not abundant in the material from Ceylon All the specimens were large and were distinguished by the number of contractile vacuoles, six being a common number Macronucleus was very prominent, and while conforming to the general pistol-shape characteristic of the species the handle-like portion at the anterior end was strongly developed and usually bent into a nearly closed loop

The specimens from *Bos gaurus* were smaller and relatively stouter than those from *B indicus*, measuring 102 (80–117) μ, or 1 42 dorso-ventral diameters in length

Habitat—Stomach of *Tragulus meminna* Milne-Edwards (mouse-deer) CEYLON, stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore, rumen of *Capra hircus* Linn BENGAL, Calcutta

Genus METADINIUM Awerinzew & Mutafowa, 1914

Metadinium, Awerinzew & Mutafowa, 1914, pp 115–18, figs 7–10
Metadinium, part, Crawley, 1923, pp 395, 400, pl xxviii, fig C, 1, Wenyon, 1926, p 1215
Eudiplodinium, part, Dogiel, 1927, pp 124–130, figs 69–72
Diplodinium, part, Becker & Talbot, 1927, p 354, fig 24
Metadinium, Kofoid & MacLennan, 1932, pp 111–16, Calkins 1933, p 515, Kofoid & Christenson, 1934, pp 370–2

Ophryoscolecidæ with dorsal and adoral membranelle zones at the anterior end of the body Two skeletal plates beneath right surface, occasionally fused at posterior end Cuticle and ectoplasm heavy Conspicuous œsophageal fibrils beneath dorsal and right lateral surfaces Two contractile vacuoles lying close to the macronucleus Large macronucleus with two or three prominent dorsal lobes

Key to Indian Species

1 (2) Body large, heavy, skeletal plates not fused at their posterior end, three dorsal lobes on the macronucleus ... *M medium* Awer & [Mut, p 332

2 (1) Body relatively short, skeletal plates fused at their posterior end, macronucleus with a large lateral lobe on its left edge ... *M rotundatum* Kof & [Christ, p 333

228 **Metadinium medium** Awerinzew & Mutafowa (Pl VII, fig 16)

Metadinium medium, Awerinzew & Mutafowa, 1914, pp 115–18, figs 7–10
Diplodinium medium, Buisson, 1923 *b*, pp 123–4, fig 45, Dogiel & Fedorowa, 1925, pp 100, 107, fig 2, Becker & Talbot, 1927, pp 353–4, fig 24
Metadinium medium, Wenyon, 1926, p 1215, fig 521 A
Eudiplodinium medium forma *medium*, Dogiel, 1927, pp 124–6, fig 69
†*Metadinium medium*, Kofoid & MacLennan, 1932, pp 113–15, pl vi, fig 16, fig G, 3, 4, Kofoid & Christenson, 1934, p 370, pl xxix, fig 25, fig F, 3, 4, Das Gupta, 1935, p 169

Body large and heavy, length 1 35–1 78 times the dorsoventral diameter, flattened laterally, anterior end blunt, posterior end truncated or slightly rounded Dorsal and ventral surfaces vary from nearly flat to distinctly convex, lateral surfaces slightly convex and ends of body smoothly rounded in dorsal view Oral area relatively large, inclined ventrally, but not inclined to the left Dorsal membranelle zone also large Operculum relatively very small Two skeletal plates extend from the border of the oral area beneath the right

surface towards the middle of the body, anterior end of each plate broader than the posterior, the dorsal plate longer and broader than the ventral plate Cuticle very heavy and covered with short, fine wrinkles arranged longitudinally, but no regular striations as in other genera Ectoplasm also very thick Endoplasmic sack relatively small, usually with two distinct projections on the dorsal and ventral sides Rectum a large cylinder, anus a large opening in the right posterior end of the body Two large contractile vacuoles in the hollows between the lobes of the macronucleus, somewhat to the right of the dorsal mid-line Macronucleus elongate, adjacent to the dorsal edge of the dorsal skeletal plate, with three large dorsal lobes, one at each end and one in its middle Micronucleus small, ovoid, lying in a slight depression along the anterior border of the middle lobe of the macronucleus

Dimensions —Length 108–224 μ (Kof & MacL), 150–272 μ (other authors)

Feeds on relatively large bits of plant débris

Remarks —The specimens from *Bos gaurus* were significantly smaller than those from *B indicus*, measuring 130–201 μ, and possessed a relatively wider mouth

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore, rumen of *Capra hircus* Linn BENGAL, Calcutta

229 **Metadinium rotundatum** Kofoid & Christenson (Pl XI, fig 11)

†*Metadinium rotundatum*, Kofoid & Christenson, 1934, pp 370–2, pl xxvii, fig 18, fig D, 1–2

Body relatively short, length 1 43–1 55 times the dorso-ventral diameter, ovoid, and slightly compressed laterally Dorsal surface regularly convex throughout its entire length, ventral surface most strongly convex in its posterior third Right surface more strongly convex than the left Posterior end extremely smoothly rounded Operculum shallow, somewhat flattened on the left Faint longitudinal striations cover the cuticle, which is relatively thick Mouth well defined, with conspicuous lips and furrows, tilted ventrally and to the left Dorsal membranelle zone at about the same level as adoral zone Skeletal complex of two plates underneath the right surface, separate in their anterior halves, fusing about the middle and continuing as one, terminating near the posterior end of the macronucleus Œsophageal fibrils prominent, extending to posterior end of endoplasm Rectum conspicu-

ous, with faint longitudinal fibrils Anus ellipsoidal, in the middle of the smoothly rounded posterior end Contractile vacuoles two, to the left of the macronucleus along the dorsal mid-line, anterior usually much larger and slightly anterior to the level of the micronucleus, posterior in the posterior concavity of the macronucleus Macronucleus elongate, with two shallow concavities on the left margin, one on each side of a large lateral lobe Micronucleus small, subspherical, lying in the anterior lateral concavity of the macronucleus

Dimensions—Length 52–73 μ breadth 34–45 μ

Feeds on plant débris

Remarks—This species is most closely related to *M ypsilon* (Dogiel, 1925) It resembles that species in having a skeletal complex of two plates fused posteriorly, a macronucleus of similar general shape, a similar position of the micronucleus and the contractile vacuoles, and a relatively thick cuticle It is, however, significantly smaller, has skeletal plates which are concave in their median unfused portions instead of being parallel, and has a macronucleus with a rounded anterior end instead of an anterior end perpendicular to its long axis

Habitat—Stomach of *Bos gaurus* H Smith Mulehole, Mysore

Genus **ELYTROPLASTRON** Kofoid & MacLennan, 1932

Polyplastron, part, Dogiel, 1928, pp 332–4, figs 4, *a*, *b*
Elytroplastron, Kofoid & MacLennan, 1932, pp 119–22, Calkins, 1933, p 515

Ophryoscolecidæ with dorsal and adoral membranelle zones at the anterior end of the body Two skeletal plates beneath right surface, a small plate beneath ventral surface, and a long plate beneath the left surface Cuticle and ectoplasm relatively heavy, conspicuous fibrils beneath dorsal and right lateral surfaces

230 **Elytroplastron bubali** (Dogiel) (Pl VII, figs 13, 14)

Diplodinium (Polyplastron) bubali, Dogiel, 1928 *b*, pp 332–4, fig 4
†*Elytroplastron bubali*, Kofoid & MacLennan, 1932, pp 121–2, pl vi, figs 13, 14, fig G, 5, 6
†*Elytroplastron bubali*, Das Gupta, 1935, p 169

Body ellipsoidal, length 1 43–1 82 times the dorso-ventral diameter, compressed laterally, posterior end smoothly rounded with no suggestion of lobes or spines Oral area relatively large, inclined ventrally, but not inclined either to left or right Dorsal membranelle zone relatively short Operculum broad but does not project anteriorly beyond the adoral zone Four skeletal plates, two, as in *Metadinium*,

extending diagonally from the edge of the adoral membranelle zone across the middle of the body, gradually fading in that region, one very short triangular plate on the left ventral side just behind the adoral zone, a fourth plate lies beneath the left surface, extending posteriorly and dorsally from the base of the operculum Endoplasmic sack narrow anteriorly and swollen in the middle Rectum heavy, tubular, beneath the right side of the body, and terminating by a narrow slit-like anus extending from the middle of the posterior end to the right side Four contractile vacuoles along the dorsal mid-line, one near the anterior end of the macronucleus, second at the level of the micronucleus, third further back, and the fourth near the posterior tip of the macronucleus Macronucleus elongate, slightly to the right of the mid-line, with a deep indentation in its left dorsal side, in which the small ellipsoidal micronucleus lies

Dimensions —Length 110–160 μ

Feeds on small pieces of plant débris and occasionally small Ciliates

Remarks —In the specimens from *Capra hircus* there are usually only two contractile vacuoles, and never more than three, and the ventral skeletal plate is slightly longer than in specimens from *B indicus*

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, rumen of *Capra hircus* Linn Calcutta

Genus **OSTRACODINIUM** Dogiel, 1927, emend Kofoid & MacLennan, 1932

Diplodinium, part, Fiorentini, 1889, p 14, pl ii, fig 3, part, Buisson, 1923 *b*, pp 120–1, figs 35, 43

Metadinium, part, Crawley, 1923, p 400, pl xxviii, fig C_3

Diplodinium, part, Fantham 1926, pp 567–8, fig 7, Becker & Talbot, 1927, pp 356, 357, figs 14, 17

Ostracodinium, part, Dogiel, 1927, pp 134–52, figs 76–86, Reichenow, 1929, p 1199, Kofoid & MacLennan, 1932, pp 122–40, Calkins, 1933, p 515, Kofoid & Christenson, 1934, pp 372 77

Ophryoscolecidæ with dorsal and adoral membranelle zones at anterior end of body Broad skeletal plate beneath right side of body A row of from two to six contractile vacuoles beneath dorsal surface Œsophageal fibrils heavy and extending to the posterior end of body.

Key to Indian Species

1 (7) With no caudal lobe or spine 2
2 (5) Posterior end smoothly rounded 3
3 (4) Macronucleus with two dorsal lobes, two contractile vacuoles *O gracile* (Dogiel) [p 337

4 (3)	Macronucleus with a small, shallow depression in the middle of the left side, three contractile vacuoles	[& MacL, p 341 *O trivesiculatum* Kof
5 (2)	Posterior end bluntly pointed	6
6	Macronucleus with a small shallow depression in the middle of the dorsal surface, four contractile vacuoles	[Kof & MacL, p 340 *O quadrivesiculatum*
7 (1)	With one or more caudal lobes	8
8 (16)	With one caudal lobe	9
9 (14)	Ventral lobe small	10
10 (11)	Macronucleus rod-like, two contractile vacuoles	[Christ, p 339 *O mysorei* Kof &
11 (10)	Macronucleus with two dorsal lobes, contractile vacuoles two or three	12 [MacL, p 342
12 (13)	With two contractile vacuoles	*O venustum* Kof &
13 (12)	With three contractile vacuoles	*O clipeolum* Kof &
14 (9)	Ventral lobe wide	15 [MacL, p 336
15	Large inturned skeletal plate, macronucleus with a depression in the middle of the left dorsal side, three contractile vacuoles	[& MacL, p 340 *O rugoloricatum* Kof
16 (8)	With two caudal lobes, one dorsal and one ventral	17
17 (18)	Macronucleus elongated, with a large shallow depresssion in the middle of the left side, three contractile vacuoles	[liet), p 338 *O mammosum* (Rail-
18 (17)	Macronucleus elongated, rod-like, two contractile vacuoles	[p 337 *O gauri* Kof & Christ,

231 **Ostracodinium clipeolum** Kofoid & MacLennan (Pl VII, fig 15)

†*Ostracodinium clipeolum* Kofoid & MacLennan, 1932, pp 135–7, pl vi, fig 15, fig J, 9, 10

Body ellipsoidal, length 1 64–2 14 times the dorso-ventral diameter, compressed laterally Dorsal surface convex in anterior half, nearly plane in posterior half, lateral surfaces convex A small, laterally flattened, shield-shaped lobe on the postero-ventral end of the body to the left of the middle line Oral area inclined ventrally and to the left Dorsal membranelle zone relatively inconspicuous Operculum small Broad skeletal plate extends laterally beneath the right surface from the macronucleus to the ventral side and posteriorly up to the posterior end of the body Œsophageal fibres extend to the posterior end of the body Small, cylindrical rectum in the middle line of the postero-ventral side of the body, and opening by a small elliptical anus Three contractile vacuoles along the dorsal side of the macronucleus, two between the anterior and posterior lobes, the third just behind the posterior lobe of the macronucleus Macro-

nucleus an elongate body beneath the right dorsal surface, with two flat lobes dorsally, one on its anterior and the other on its posterior half Micronucleus ellipsoidal, in a depression on the dorsal side of the macronucleus

Dimensions —Length 92–128 μ

Feeds on large bits of plant débris

Remarks —This species resembles *O dogieli* Kof & MacL in proportions, size and the shape of the caudal lobe The caudal lobe is often reduced, and may be little more than a semicircular flap.

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

232 **Ostracodinium gauri** Kofoid & Christenson (Pl XI, fig 14)

†*Ostracodinium gauri*, Kofoid & Christenson, 1934, pp 375–6, pl xxviii, fig 21, fig G, 7, 8

Morphologically identical with *O mysorei* in all respects except caudal armature; two caudal lobes of subequal size present, one ventral, the other dorsal Anal opening lies at the base of the dorsal surface of the ventral lobe

Dimensions —Length 44–70 μ, breadth 23–40 μ

Remarks —This species is related to *O mysorei* in size and shape of the body, shape of macronucleus, shape of skeletal plate, posterior diverticulum of endoplasmic sack, and the number of vacuoles, but differs in possessing two caudal lobes It differs from *O dilobum* Dogiel (1927), in being of smaller size, in having two vacuoles instead of five, and in possessing a posterior diverticulum of the endoplasmic sack

Habitat —Stomach of *Bos gaurus* H Smith Mulehole, Mysore

233 **Ostracodinium gracile** (Dogiel) (Pl VIII, fig 18)

Diplodinium gracile forma gracile, Dogiel, 1925 *a*, pp 130, 133 141, fig 5, 1925 *b*, pp 297–301, figs B, E–L, E_1–M_1, E_2–G_2

Ostracodinium gracile forma gracile, Dogiel, 1927, pp 144–6, fig 81, *d*

†*Ostracodinium gracile*, Kofoid & MacLennan, 1932, pp 27–9, pl vii, fig 18, fig J, 1, 2, Kofoid & Christenson, 1934, p 376, pl xxviii, fig 22, fig G, 1, 2

Body roughly triangular, length 1 75–2 16 times the dorso-ventral diameter Ventral and left surfaces plane, right and dorsal surfaces convex, posterior end smoothly rounded Oral area prominent, inclined ventrally, but not inclined to the right or the left Dorsal membranelle zone and the

operculum relatively prominent A broad skeletal plate beneath the right surface, extending laterally from the macronucleus to the ventral surface Œsophageal fibrils extending to the posterior end of body Two contractile vacuoles, close against the dorsal edge of the macronucleus, one vacuole in the depression behind each lobe of the macronucleus Macronucleus elongate lying along the right dorsal surface, with two dorsal lobes, one at its anterior end and one in the middle Micronucleus small ellipsoidal, lying between the two lobes of the macronucleus

Dimensions —Length 90–133 μ

Feeds on relatively large pieces of plant débris

Remarks —This species is closely allied to *O trivesiculatum* Kof & MacL and *O tenue* (Dog) in its triangular shape, size proportions of the body, and in the lack of spines It is also closely related in shape and proportions to two spined species, *O nanum* (Dog) and *O gladiator* (Dog) The conjugation of *O gracile* has been described by Dogiel (1925 c)

Specimens of *O gracile* from *Bos gaurus* were smaller and relatively shorter than individuals from *B indicus* They measure 60–85 μ and the length is 1 58–1 85 times the dorsoventral diameter

Habitat —Stomach of *Bos indicus* Linn MADRAS Coonoor CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore

234 Ostracodinium mammosum (Railliet) (Pl VIII fig 17)

Diplodinium dentatum, Fiorentini, 1889, pp 14, 24, pl ii fig 3
Diplodinium mammosum Railliet, 1890, pp 318–19, 1895 p 181.
Diplodinium dentatum, da Cunha, 1914, pp 63, 64, Sharp, 1914, p 60, Buisson, 1923 *b*, pp 120–1, fig 35, Becker & Talbot, 1927, pp 353, 356, pl ii, fig 14
Diplodinium fiorentinii, Awerinzew & Mutafowa, 1914, pp 110–11, figs 1, 2, Buisson, 1923 *b*, p 120 fig 43
Metadinium dentatum, Crawley, 1923, p 400
Ostracodinium dentatum, Dogiel, 1927, pp 139–42, fig 79, *a*, *b*
†*Ostracodinium mammosum*, Kofoid & MacLennan, 1932, pp 125–6 pl vii, fig 17, fig G, 1, 2

Body relatively short, length 1 55–1 92 times the dorsoventral diameter Ventral surface convex in anterior half, then flat or slightly concave, and convex again in the posterior region, dorsal surface convex, lateral surfaces convex One dorsal caudal lobe the ventral lobe hollow on its dorsal side Oral area inclined ventrally and to the left Adoral membranelle zone relatively well developed Operculum large Skeletal plate broad, anteriorly extending beneath the right surface from the anterior end of the macronucleus to the ventral side,

narrowing posteriorly and extending to the bases of the caudal lobes Œsophagus and endoplasmic sack marked by heavy fibrils Rectum a dorso-ventrally flattened tube, elliptical anus in the concave side of the ventral lobe Three contractile vacuoles beneath the dorsal surface of the body, anterior near the anterior end of the macronucleus and the posterior near the level of the posterior end of the macronucleus Macronucleus long, rod-like, lying beneath the right dorsal surface, with a large shallow depression in its left side, near which lies the median contractile vacuole Micronucleus small, ellipsoidal, in a small depression near the middle of the dorsal surface of the macronucleus

Dimensions —Length 41–110 μ

Feeds on small bits of plant débris

Remarks —This species resembles *O dilobum* Dogiel in the general form of the body and in possessing two caudal lobes, but it is smaller, has fewer vacuoles, and the caudal lobes are relatively larger The ventral lobe is not scoop-shaped in *O dilobum*

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

235 **Ostracodinium mysorei** Kofoid & Christenson (Pl XI, fig 15)

†*Ostracodinium mysorei*, Kofoid & Christenson, 1934, pp 372–5, pl xxviii, fig 23, fig G, 5, 6, 9–12

Body short and relatively stout, length 1 16–1 60 times the dorso-ventral diameter, strongly compressed laterally Ventral and left surfaces slightly convex, right and dorsal surfaces more strongly convex Dorsal membranelle zone at nearly the same transverse level as the adoral zone, and separated from it by the rounded operculum One ventral caudal lobe of variable size, usually small Posterior end of the body dorsal to the anus, smoothly rounded A broad skeletal plate, consisting of about 20 to 30 longitudinal rows of polygonal prisms, lies underneath the right surface of the body, is wider in its anterior third, and extends backwards to the posterior end of the macronucleus Mouth tilted ventrally and to the left Œsophagus conspicuously fibrillated, the fibrils terminating at the posterior end of the endoplasmic sack The endoplasmic sack forms a conspicuous diverticulum extending to the postero-dorsal surface of the body Rectum conspicuous but undifferentiated, opening by a broad slit anus on the dorsal side of the base of the caudal lobe Contractile vacuoles two, subequal, along the left edge of the macronucleus, one slightly anterior and the other slightly posterior to the level

of the macronucleus Macronucleus is a straight rod-like structure along the dorsal mid-line, gradually widening in anterior third Micronucleus is small, subspherical, contained in a slight concavity on the left dorsal edge of the middle of the macronucleus

Dimensions —Length 42–53 μ, breadth 26–30 μ

Feeds on plant débris

Remarks —The species is closely related to *O gauri*, except that it possesses a single ventral lobe

Habitat —Stomach of *Bos gau us* H Smith Mulehole, Mysore

236 **Ostracodinium quadrivesiculatum** Kofoid & MacLennan (Pl VIII, fig 19)

†*Ostracodinium quadrivesiculatum*, Kofoid & MacLennan, 1932, pl vii, fig 19, fig J, 7, 8

Body triangular in side view, length 1 96–2 24 times the dorso-ventral diameter, only slightly compressed laterally Ventral surface flat or slightly convex, dorsal surface strongly convex Left surface only slightly convex, right surface strongly so Posterior end smoothly rounded Oral area relatively large, not inclined ventrally, but inclined to the left Dorsal membranelle zone relatively large Operculum prominent and extending anteriorly considerably beyond the adoral lips Broad skeletal plate extends laterally from the right surface of the macronucleus to the ventral surface, and posteriorly to the posterior quarter of the body Œsophageal fibrils extending to the posterior end of the body Rectum narrow, cylindrical, opening by an elliptical anus in the posterior end of the body, near the ventral surface Four contractile vacuoles along the left dorsal surface of the macronucleus, one pair anterior to the micronucleus, the other near the posterior end of the macronucleus Macronucleus elongate, rod-like, beneath the right dorsal surface, with a small shallow depression in the middle of its dorsal surface, in which lies the small ellipsoidal micronucleus

Dimensions —Length 92–112 μ

Feeds on large bits of plant débris

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

237 **Ostracodinium rugoloricatum** Kofoid & MacLennan (Pl VIII, fig 20)

†*Ostracodinium rugoloricatum*, Kofoid & MacLennan, 1932, pp 137–9, pl vii, fig 20, figs I, 1, J, 11, 12

Body rectangular in lateral view, length 1 78–2 16 times the

dorso-ventral diameter, ellipsoidal in dorsal view, with both ends bluntly rounded. Ventral surface flat or slightly concave in the anterior three-quarters, convex in posterior quarter. Dorsal surface flat or slightly concave in the anterior half, strongly convex in the posterior half. Left surface flat, right convex. A wide flattened ventral lobe on the ventral third of the posterior end of the body. Oral area somewhat smaller than in *O. gracile* (Dog.), inclined ventrally and to the left. Dorsal membranelle zone relatively small. Operculum relatively large. Broad skeletal plate extends laterally from the macronucleus to the ventral side of the body, its dorsal edge folds inward near the macronucleus and extends toward the middle of the body. Heavy œsophageal fibrils pass from the anterior end of the endoplasmic sack to its posterior end. Rectum wide, strongly compressed dorso-ventrally, opening to the exterior by the thin slit-like anus. Three contractile vacuoles lie along the left dorsal edge of the macronucleus, one at the level of the anterior edge of the macronucleus, second just behind the micronucleus, and the third near the posterior end of the macronucleus. Macronucleus straight, narrow, rod-like, under the right dorsal edge of the body, with a deep depression in the middle of its left dorsal side, in which the small, ellipsoidal micronucleus lies.

Dimensions.—Length 84–125 μ.

Feeds on small bits of plant débris.

Remarks.—The exceptionally large inturned skeletal plate, the ventral lobe, dorso-ventrally compressed rectum and slit-like anus separate this species from the other species of the genus.

Habitat.—Stomach of *Bos indicus* Linn. MADRAS, Coonoor; CEYLON, Colombo.

238. **Ostracodinium trivesiculatum** Kofoid & MacLennan. (Pl. VIII, fig. 22.)

†*Ostracodinium trivesiculatum*, Kofoid & MacLennan, 1932, pl. vii, fig. 22, fig. J, 3, 4; Kofoid & Christenson, 1934, p. 377, pl. xxviii, fig. 24, fig. G, 3, 4.

Body triangular in lateral view, length 1.67–2.34 times the dorso-ventral diameter, slightly compressed laterally. Ventral and left surfaces nearly flat, dorsal and right surfaces strongly convex. Posterior end smoothly rounded. Oral area relatively large, inclined ventrally, but not inclined to the left or right. Dorsal membranelle zone somewhat smaller than in *O. gracile*. Operculum fairly prominent. Broad skeletal plate extends laterally from the macronucleus to the ventral surface. Œsophageal fibrils extend to the posterior end of body. Rectum a narrow cylinder, opening by a small circular

anus in the ventral part of posterior end Three contractile vacuoles, one just anterior to the micronucleus, one just posterior to it, and one at the level of the posterior end of the macronucleus Macronucleus long, rod-like, lying along the right dorsal surface, with a small, shallow depression in the middle of the left side and occasionally in the posterior end, it is curved parallel to the curvature of the right side Micronucleus small, ellipsoidal, lying in a small depression in the middle of the dorsal surface of the macronucleus

Dimensions —Length 78–100 μ

Feeds on large bits of plant débris

Remarks —Specimens from *Bos gaurus* were shorter and relatively stouter than those from *B indicus* They measure 72–91 μ and the length is 1 70–2 02 times the dorso-ventral diameter

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore

239 **Ostracodinium venustum** Kofoid & MacLennan (Pl VIII, fig 21)

†*Ostracodinium venustum*, Kofoid & MacLennan, 1932, pp 134–5, pl VII, fig 21, fig J, 5, 6

Body triangular in side view, length 1 76–2 06 times the dorso-ventral diameter, laterally compressed, ellipsoidal in dorsal view Ventral surface nearly plane, dorsal surface convex, lateral surfaces convex A small caudal lobe projects from the postero-ventral end of the body to the left of the middle line Oral area inclined ventrally and to the left Dorsal membranelle zone well developed Operculum small Broad skeletal plate beneath the right surface, extending laterally between the macronucleus and the ventral side, and posteriorly up to the posterior quarter of the body Œsophageal fibrils extending to and terminating at the posterior end of the endoplasmic sack Small, tubular rectum lies along the mid-line in the postero-ventral end of the body, and opens by a circular anus just dorsal to the ventral lobe Two contractile vacuoles lie dorsally and to the left of the macronucleus, one behind each of its dorsal lobes Macronucleus elongate, beneath the dorsal surface slightly to the right of the middle line, with two dorsal lobes, one at the anterior end and one just behind the middle Micronucleus on the dorsal side of the macronucleus just in front of the median lobe

Dimensions —Length 76–115 μ

Feeds on large bits of plant débris

Remarks —This species is similar to *O gracile* in shape, size, number of vacuoles, and shape of macronucleus, but differs in possessing a small ventral lobe

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

Genus **EPIDINIUM** Crawley, 1923

Epidinium, Crawley, 1923, pp 394, 401, part, Dogiel, 1927, pp 156–81 figs 90–9, Wenyon, 1926, p 1215, Reichenow, 1929, p 1200, Kofoid & MacLennan, 1932, p 61, 1933, pp 1–17, Calkins, 1933, p 515, Kofoid & Christenson, 1934, pp 365–7, Das Gupta, 1935, pp 169–70

Ophryoscolecidæ with body elongate and twisted around the main axis Dorsal membranelle zone behind the anterior end of the body Main skeletal complex composed of three plates Macronucleus a straight, elongate body Two contractile vacuoles present

Remarks —The morphology of this genus is more accurately known than that of the other genera in the family Fiorentini (1889) described *Diplodinium ecaudatum*, *D caudatum*, and *D cattanei* Eberlein (1895) described another species under the name of *D caudatum* which was renamed *D eberleini* by da Cunha (1914) Sharp (1914) redescribed two of Fiorentini's species and three new ones, but considered them all as forms of *D ecaudatum* This group is marked off from the rest of the species of *Diplodinium* by the shape of the body, size and position of the membranelle zones, and the number of skeletal plates In these respects the group shows closer resemblance to *Ophryoscolex* than to *Diplodinium*, and this resemblance led da Cunha (1914), Awerinzew & Mutafowa (1914), and Dogiel (1925 *b*) to place it in the genus *Ophryoscolex* Crawley (1923) showed that the group belonged to neither of these two genera, and erected a new genus *Epidinium* for it

Key to Indian Species

1 (14)	Body elongate	2
2 (13)	Body tapering posteriorly	3
3 (4)	Smoothly rounded posteriorly, without caudal spine	*E ecaudatum* (Fior), [p 344
4 (5)	Single ventral caudal spine	*E caudatum* (Fior),
5 (4)	With more than one caudal spine	6 [p 346
6 (7)	Without lateral spines	7
7	With a large ventral spine and a smaller dorsal spine	*E bicaudatum* (Sharp), [p 347
8 (6)	With one or more lateral spines	9
9 (10)	With a large ventral spine, a dorsal spine, and a right lateral spine	*E tricaudatum* (Sharp), [p 347
10 (9)	With a large ventral spine, a dorsal spine, and two or more lateral spines	11
11 (12)	With two right lateral spines	*E quadricaudatum* [(Sharp), p 348

12 (11) With two right lateral and one left lateral spines — *E parvicaudatum* (Aw. & Mut), p 349.

13 (2) Body with a relatively blunt posterior end, with blunt caudal lobes, and with an accessory skeletal plate in the single long ventral spine — *E eberleini* (da Cunha), p 351

14 (1) Body relatively short and truncate posteriorly, five long straight caudal spines — *E cattanei* (Fior), p 350

"ECAUDATUM" GROUP —The six species constituting this group were first assembled by Sharp (1914) as forms belonging to a single species, *Diplodinium ecaudatum* These forms are now regarded as distinct species

The group is characterized by a tapering of the posterior half of the body, which terminates in the small rounded posterior end Speciation within this series is based upon the spination of this small posterior end There is a complete series of species ranging from *E ecaudatum* with no spine to *E parvicaudatum* with five small conical spines *E caudatum* has a single large ventral spine *E bicaudatum* has a smaller dorsal spine in addition to the ventral spine A right lateral spine is added in *E tricaudatum* *E quadricaudatum* has both a right and a left lateral spine in addition to the dorsal and ventral spines *E parvicaudatum* has two right lateral spines, making a total of five spines

240 **Epidinium ecaudatum** (Fiorentini) (Fig 164)

Diplodinium ecaudatum, Fiorentini, 1889, pp 15–16, pl iii, figs. 1, 2
Diplodinium caudatum, Eberlein, 1895, pp 263–4, fig 19
Diplodinium ecaudatum forma *ecaudatum*, Sharp, 1914, pp 62–90, figs A–D , pls iii, vi, vii
Ophryoscolex inermis, da Cunha, 1914, pp 58, 60–61
Ophryoscolex labiatus, Awerinzew & Mutafowa, 1914, pp 114–15, fig 6
Epidinium ecaudatum, Crawley, 1923
†*Diplodinium ecaudatum*, Jameson, 1925, p 408
Epidinium ecaudatum forma *ecaudatum*, Dogiel, 1927, pp 159–61, fig 90 , 1932, p 97
†*Epidinium ecaudatum*, Das-Gupta, 1935, p 170

Body relatively long, length 2 3–2 9 times the dorso-ventral diameter, tapering and smoothly rounded posteriorly

Dimensions —Length 90–152 μ

Remarks —In the stomach contents of the mouse-deer from Ceylon, examined by Pringle Jameson, the species was present in five of the forms described by Sharp (1914)—*ecaudatum*, *caudatum*, *bicaudatum*, *tricaudatum*, and *quadricaudatum* Of these the first three were more abundant The forms were not quite typical They were built much more squarely, especially at the posterior end, and the spines, where

present, were much shorter and more acutely pointed, more compressed and more fragile, more thorn-like than spine-like, than are usually found in similar varieties from European Ruminants The forms included under *E ecaudatum* are

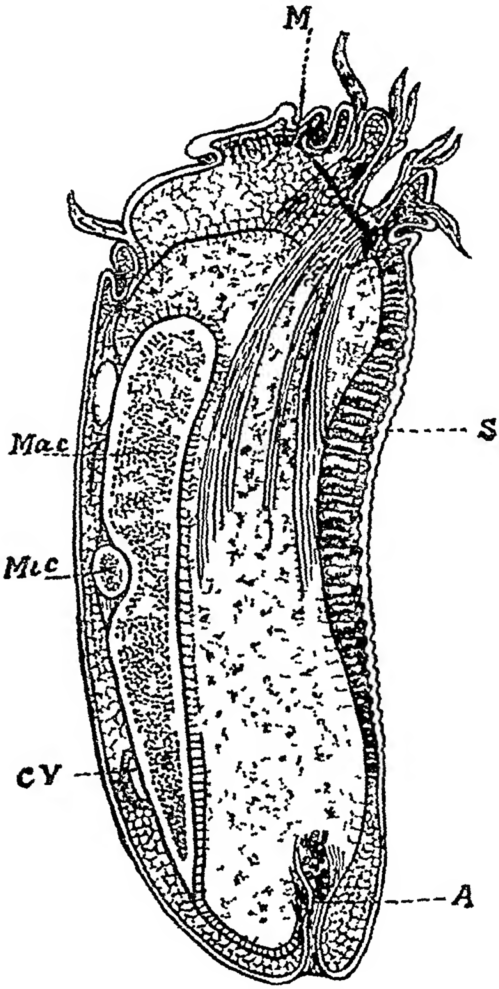


Fig 164—*Epidinium ecaudatum* (Fiorentini) *A*, anal canal, *C V*, one of the two contractile vacuoles, *M*, motorium with fibre to circumpharyngeal ring, *Mac*, macronucleus, *Mic*, micronucleus, *S*, skeletal layer (After Sharp)

now regarded as distinct species, and *E ecaudatum* is the simplest member of the "*Ecaudatum*" group

Habitat—Stomach of *Tragulus meminna* Milne-Edwards (mouse-deer) CEYLON, rumen of *Capra hircus* Linn BENGAL, Calcutta

241 **Epidinium caudatum** (Fiorentini) (Pl IX, fig 1)

Diplodinium caudatum, Fiorentini, 1889, p 21, pl iii, fig 2
Diplodinium ecaudatum forma *caudatum*, Sharp, 1914, pp 90–1, pl v, fig 6
Ophryoscolex inermis var *caudatus*, da Cunha, 1914, p 113, fig 40
Ophryoscolex intermixtus, Awerinzew & Mutafowa, 1914, pp 112–13, fig 3
Epidinium caudatum, Crawley, 1923, p 412, pl xxix, figs D4–D6
Diplodinium ecaudatum forma *caudatum* Buisson, 1923 *b*, pp 113–17, fig 39
Ophryoscolex ecaudatus forma *caudatus*, Dogiel, 1925 *a*, pp 137, 141, 1925 *d*, pp 57–59, Dogiel & Fedorowa, 1925, p 102, fig 6
†*Diplodinium caudatum*, Jameson, 1925, p 408
Diplodinium ecaudatum, Wenyon, 1926, p 1214, fig 520
Epidinium ecaudatum forma *caudatum* Dogiel, 1927, pp 161–3, fig 91 *a–c*, 1932, pp 97–8
Diplodinium ecaudatum forma *caudatum*, Becker & Talbot, 1927, pp 354–5, pl iii, fig 25
Epidinium caudatum, Dogiel, 1927, p 269
†*Epidinium caudatum*, Kofoid & MacLennan, 1933, pp 5–7, pl. i, fig 1, fig A, 1, 2, Kofoid & Christenson, 1934 p 365, pl xxvii, fig 15, fig D, 3, 4, Das Gupta, 1935 p 170

Body elongate, length 2 04–2 86 times the dorso-ventral diameter, tapering towards the posterior end Ventral and left surfaces flat or slightly concave, dorsal and right surfaces strongly convex Oral area inclined ventrally and to the left Single caudal spine arises from the postero-ventral end of the body and curves dorsally and to the right Cuticle with fine longitudinal striations Three skeletal plates extend from the operculum and the right side of the oral area posteriorly past the middle of the body Endoplasmic sack extends from the level of the dorsal membranelle zone to the posterior end of the body Rectum narrow, lined by fine longitudinal fibrils, with a narrow, elliptical anus Two contractile vacuoles beneath the dorsal surface to the right of the dorsal middle line Macronucleus elongate, lying beneath the right dorsal surface adjacent to the edge of the dorsal skeletal plate Micronucleus a small ellipsoidal body lying in a depression in the macronucleus

Dimensions —Length 85–140 μ

Feeds on Bacteria and small Flagellates

Remarks —Specimens from *B gaurus* are smaller (80–118 μ) than the specimens from *B indicus* (85–140 μ)

Habitat —Stomach of *Bos indicus* Linn CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore, stomach of *Tragulus meminna* Milne-Edwards CEYLON, rumen of *Capra hircus* Linn BENGAL, Calcutta

242 **Epidinium bicaudatum** (Sharp) (Pl IX, fig 4)

Diplodinium ecaudatum forma *bicaudatum*, Sharp, 1914, p 92, pl v, fig 7
Epidinium bicaudatum, Crawley, 1923 p 412
†*Diplodinium bicaudatum*, Jameson, 1925, p 408
Epidinium ecaudatum forma *bicaudatum*, Dogiel, 1927, pp 166–7, figs 94, 95 c
†*Epidinium bicaudatum*, Kofoid & MacLennan, 1933, pp 7–8, pl i, fig 4, fig A, 3, 4

Body elongate, length 2 10–2 88 times the dorso-ventral diameter, tapering towards the posterior end Ventral and left surfaces concave, dorsal and right surfaces strongly convex Oral area inclined ventrally and to the left A large ventral caudal spine arises from the postero-ventral end of the body and curves dorsally and to the right, and a small dorsal spine arises from the postero-dorsal end of the body and curves ventrally Cuticle with fine longitudinal striations Three skeletal plates extend from the operculum and the right side of the oral area posteriorly past the middle of the body Endoplasmic sack extends from the level of the dorsal membranelle zone to the posterior end of the body Rectum narrow, lined by fine longitudinal fibrils, with a narrow elliptical anus Two contractile vacuoles beneath the dorsal surface slightly to the right of the middle line Macronucleus elongate, lying beneath the right dorsal surface adjacent to the edge of the dorsal skeletal plate, somewhat longer and narrower than in the preceding species Micronucleus a small ellipsoidal body lying in a depression in the macronucleus

Dimensions —Length 82–144 μ

Feeds on Bacteria and small Flagellates

Habitat —Stomach of *Bos indicus* Linn CEYLON, Colombo, stomach of *Tragulus meminna* Milne-Edwards CEYLON

243 **Epidinium tricaudatum** (Sharp) (Pl IX, fig 2)

Diplodinium ecaudatum forma *tricaudatum*, Sharp, 1914, p 92, pl v, fig 8, Buisson, 1923 *b*, p 117, fig 29, Becker & Talbot, 1927, p 355, fig 25 *a*
Epidinium tricaudatum, Crawley, 1923, p 412
†*Diplodinium tricaudatum*, Jameson, 1925, p 408
Ophryoscolex ecaudatus forma *tricaudatus*, Dogiel, 1926 *a*, p 253
Epidinium ecaudatum forma *tricaudatum*, Dogiel, 1927, pp 167–8, fig 95, *a*, *b*
†*Epidinium tricaudatum*, Kofoid & MacLennan, 1933, pp 8–10, pl i, fig 2, fig B, 1, 2

Body elongate, length 2 02–2 50 times the dorso-ventral diameter, tapering towards the posterior end Ventral and left surfaces flat or slightly concave, dorsal and right surfaces

convex Oral area inclined ventrally and to the left There are three spines, the largest of the three is ventral, arises from the postero-ventral end of the body, and curves dorsally and to the right, there is a small dorsal spine and a small right lateral spine The dorsal and lateral spines vary from small points to large spines only slightly smaller than the ventral spine Cuticle with fine longitudinal striations Three skeletal plates extend from the edge of the oral area posteriorly to the level of the posterior end of the macronucleus Endoplasmic sack extends from the level of the dorsal membranelle zone to the posterior end of the body Rectum narrow, lined with fine longitudinal fibrils, with a narrow elliptical anus Two contractile vacuoles beneath the dorsal surface at the right of the mid-line Macronucleus elongate, lying beneath the right dorsal surface adjacent to the edge of the dorsal skeletal plate Micronucleus a small ellipsoidal body lying in a shallow depression in the macronucleus

Dimensions —Length 85–131 μ

Feeds on Bacteria and small Flagellates

Habitat —Stomach of *Bos indicus* Linn CEYLON, Colombo. stomach of *Tragulus meminna* Milne-Edwards CEYLON

244 **Epidinium quadricaudatum** (Sharp) (Pl IX, fig 3)

Diplodinium ecaudatum forma *quadricaudatum*, Sharp, 1914, pp 93–4, pl v, fig 9, Buisson, 1923 *b*, p 117, fig 39
Epidinium quadricaudatum, Crawley, 1923, p 412
†*Diplodinium quadricaudatum*, Jameson, 1925, p 408
Ophryoscolex ecaudatus forma *quadricaudatus*, Dogiel, 1926 *a*, p 254
Epidinium ecaudatum forma *quadricaudatum*, Dogiel, 1927, pp 168–9, fig 96 *a*, *b*
†*Epidinium quadricaudatum*, Kofoid & MacLennan, 1933, pp 10–11, pl i, fig 3, fig B, 3, 4, Kofoid & Christenson, 1934, p 365, pl xxvii, fig 16, fig D, 5, 6

Body elongate, length 2 27–2 32 times the dorso-ventral diameter, tapering posteriorly Ventral and left surfaces strongly concave, dorsal and right surfaces convex Oral area inclined ventrally and to the left There are four spines, the ventral spine is the longest, arises from the postero-ventral end of the body, and curves dorsally and to the right, there are two right lateral spines in place of the single lateral in the preceding species, and a small dorsal spine The two lateral spines are shortest and nearly equal, and the dorsal spine is slightly larger than the lateral spines Cuticle with fine longitudinal striations The three skeletal plates lie beneath the right and ventral sides, and extend from the edge of the oral area posteriorly to the level of the posterior end of the macronucleus Endoplasmic sack extends from the level of the dorsal membranelle zone to the posterior end of the body.

Rectum narrow, with fine longitudinal fibrils, with the anus lying between the bases of the ventral and lateral spines Two contractile vacuoles beneath the dorsal surface at the right of the middle line Macronucleus elongate, lying beneath the right dorsal surface, adjacent to the dorsal skeletal plate Micronucleus a small ellipsoidal body in a shallow depression in the macronucleus

Dimensions —Length 110–119 μ

Feeds on Bacteria and small Flagellates

Remarks —The single specimen from *Bos gaurus* was distinctly smaller (88 μ in length) than specimens from *B indicus*

Habitat —Stomach of *Bos indicus* Linn CEYLON, Colombo, stomach of *Bos gaurus* H Smith Mulehole, Mysore, stomach of *Tragulus meminna* Milne-Edwards CEYLON

245 **Epidinium parvicaudatum** (Awerinzew & Mutafowa) (Pl XI, fig 10)

Diplodinium ecaudatum forma *cattanei*, Sharp, 1914, pp 94–5, pl iii, figs 4, 5
Ophryoscolex fasciculus var *parvicaudata*, Awerinzew & Mutafowa, 1914, pp 113–14, pl iv, fig 5
Epidinium ecaudatum forma *cattenoi*, Dogiel, 1927, pp 169–71, fig 97
Diplodinium ecaudatum forma *catteneoi*, Becker & Talbot 1927, p 355
Epidinium ecaudatum forma *cattenoi*, Dogiel, 1932, p 97
Epidinium parvicaudatum, Kofoid & MacLennan, 1933, p 11
†*Epidinium parvicaudatum*, Kofoid & Christenson, 1934, pp 365–7, pl xxvii, fig 17 fig D, 7, 8

Body relatively long, 2 4–2 8 dorso-ventral diameters in length, almost circular in cross-section, tapering posteriorly Ventral and left surfaces nearly plane or only slightly convex, dorsal and right surfaces show greater convexity Five caudal spines present—one large ventral with its extremity curved dorsally, one dorsal, one on the left side, and two on the right side Fine longitudinal striations over the cuticle Three skeletal plates lie underneath the right surface of the body and extend up to the posterior fourth of the body Oral apparatus moderate sized, tilted ventrally and to the left Operculum wide, smoothly rounded, separating adoral from the dorsal membranelle zones The dorsal zone is set back on the dorsal surface about one-fifth of the body-length from the anterior end Contractile vacuoles two, on the dorsal surface to the left of the macronucleus Macronucleus elongated, rod-like, lies next to the right dorsal surface, adjacent to the dorsal edge of the skeletal complex Micronucelus small, ellipsoidal, in a slight concavity in the mid-dorsal edge of the macronucleus

Dimensions—Length 70–120 μ, breadth 37–47 μ.

Feeds on Bacteria and small Flagellates

Remarks—Sharp (1914) identified his five-spined species as *Diplodinium cattanei* Fiorentini, 1889, but at the same time pointed out serious discrepancies between his description and that of Fiorentini. Awerinzew and Mutafowa (1914) and Dogiel (1927) have separated them. Awerinzew and Mutafowa gave the short-spined type the forma name *parvicaudata*, so the name *E. cattanei* (Fiorentini) clearly belongs to the long-spined species.

Habitat—Stomach of *Bos gaurus* H. Smith. Mulehole, Mysore.

UNALLOCATED SPECIES—Three species of *Epidinium*—*E. gigas*, *E. cattanei*, and *E. eberleini*—do not fit in with the *E. ecaudatum* group or the *E. hamatum* group (not known from India so far). *E. gigas* has so far not been met with in Indian material. *E. cattanei* is recognizable by the truncated posterior end and by very long peculiarly shaped spines, and *E. eberleini* by the presence of an accessory skeletal plate in the main caudal spine and by the presence of two lateral lobes.

246. **Epidinium cattanei** (Fiorentini). (Pl. IX, fig. 7.)

Diplodinium cattanei, Fiorentini, 1889, pp. 16–17, pl. iii, figs. 4, 5.
Ophryoscolex cattanei, Railliet, 1890.
Ophryoscolex cattaneoi, da Cunha, 1914, pp. 62, 63.
Ophryoscolex fasciculus, part, Awerinzew & Mutafowa, 1914, pp. 112–14, fig. 4.
Diplodinium ecaudatum var. *cattanei*, Buisson, 1923 *b*, pp. 118–19, fig. 42.
Diplodinium ecaudatum forma *cattanei*, part, Becker & Talbot, 1927, p. 355.
Epidinium cattanei, Crawley, 1923, p. 412.
Ophryoscolex ecaudatus cattaneoi, Dogiel, 1926 *a*, p. 254.
Epidinium ecaudatum forma *fasciculus*, Dogiel, 1927, pp. 171–3, fig. 98.
Epidinium caudatum forma *fasciculus*, Dogiel, 1927, p. 171.
†*Epidinium cattanei*, Kofoid & MacLennan, 1933, pp. 13–15, pl. i, fig. 7, fig. C, 1, 2.
†*Epidinium cattenoi*, Das Gupta, 1935, p. 170.

Body relatively short and heavy, length 1.63–2.38 times the dorso-ventral diameter, truncated posteriorly. Ventral surface slightly concave; left and dorsal surfaces concave between the dorsal membranelle zone and the base of the left spine; the right surface is convex. Oral area is inclined ventrally and to the left. There are five long, straight, caudal spines, which are the largest and most prominent spines found in any of the Ophryoscolecidæ. Each spine arises from a

relatively broad base, but tapers rapidly in the proximal third, so that the distal two-thirds are relatively thin The largest spine projects from the ventral side of the posterior end of the body, two spines from the dorsal side, and one from each side between the ventral and dorsal spines Cuticle with fine longitudinal striations The three skeletal plates extend around the oral area from the operculum to the ventral sides, gradually narrowing posteriorly The dorsal plate is usually shorter than the other two and often ends near the level of the anterior contractile vacuole, the middle and ventral plates terminating posteriorly a short distance behind the middle of the body Endoplasmic sack extends from the level of the dorsal membranelle zone to the posterior end of the body Rectum small, narrow, with a narrow elliptical anus near the dorsal side of the base of the ventral spine Two contractile vacuoles beneath the dorsal surface, the large anterior located at the right of the middle line, the smaller posterior located very near it Macronucleus elongate, lying beneath the right dorsal surface adjacent to the edge of' the dorsal skeletal plate Micronucleus a small ellipsoidal body lying in a shallow depression of the macronucleus.

Dimensions —Length 78–120 μ

Feeds on Bacteria and small Flagellates

Remarks —The relatively short truncated body and the peculiar shape of the very long spines separate this species from the other species of the genus

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo, rumen of *Capra hircus* Linn BENGAL, Calcutta

247 **Epidinium eberleini** (da Cunha) (Pl IX, fig 5)

Diplodinium caudatum, Eberlein, 1895 pp 260–1 fig 16
Diplodinium eberleini, da Cunha, 1914, p 62, Sharp, 1914, pp 51, 61, Buisson, 1923 *b*, pp 118–20, fig 36
Diplodinium longispinum, Schulze, 1924 p 656
Diplodinium eberleini, Dogiel, 1927, p 156, fig 89, Becker & Talbot, 1927, p 355
Epidinium lobatum, Dogiel, 1928 *b*, pp 334–7, fig 5, *a*, *b*
†*Epidinium eberleini*, Kofoid & MacLennan, 1933, pp 16–17, pl 1, fig 15, fig D, 1, 2

Body elongate, length 1 82–2 32 times the dorso-ventral diameter, with a relatively blunt posterior end Ventral and left surfaces nearly plane, right surface strongly convex, anterior half of dorsal surface convex, posterior half concave or plane Oral area inclined ventrally and to the left Right side of the body continued posteriorly as a broad laterally flattened lobe, a narrower heavier lobe projecting from the posterior end of the left surface A large curved spine arises

from the posterior end and a long, thin, accessory skeletal plate extends from the middle of the ventral surface to the tip of the large spine Endoplasmic sack extends from the level of the dorsal membranelle zone to the posterior end of the body Rectum narrow, with the anus opening at the base of the ventral spine between the two lateral lobes Two contractile vacuoles lie beneath the dorsal surface, the anterior at the right of the mid-line, the posterior on the mid-line Macronucleus elongated, lying adjacent to the dorsal edge of the main skeletal complex Micronucleus a small ellipsoid body lying in a shallow depression of the macronucleus

Dimensions —Length 85–118 μ

Feeds on Bacteria and small Flagellates

Remarks —This species is marked off from other species of the genus by the appearance of its caudal lobes and by the presence of the accessory skeletal plate in the ventral spine

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor, CEYLON, Colombo

Genus **OPHRYOSCOLEX** Stein, 1858

Ophryoscolex, Stein, 1858, p 69, 1859 *a*, pp 57–8
Diplodinium, part, Fiorentini, 1889, pp 11–12, pl i, figs 1–2
Ophryoscolex, Eberlein, 1895, pp 239–51, pl xvi, figs 1–7, Buisson, 1923 *a*, p 237
Ophryoscolex, part, Dogiel, 1925 *a*, pp 134–5, 1927, pp 183–211, figs 103–17
Ophryoscolex, Wenyon, 1926, p 1217, Becker & Talbot, 1927, pp 358–9, pl iii, figs 26, 27, Reichenow, 1929, p 1201, Kofoid & MacLennan, 1932, p 61, 1933, pp 19–26

Ophryoscolecidæ with dorsal membranelle zone situated about one-third the length of the body from the anterior pole, forming a girdle extending three-fourths the distance around the body and open only on right ventral side Skeletal complex formed of three plates extending the length of the right ventral side Nine to fifteen vacuoles ranged around the body in two transverse rows

Remarks —*Ophryoscolex* was first described by Stein (1858) as the type-genus of a new family He gave a very good description, and described *O purkynjei*, a common species with a complex array of caudal spines, and *O inermis*, a rare species with a smooth posterior end Fiorentini (1889) redescribed *O purkynjei* as *Diplodinium vortex* Eberlein (1895) described *O caudatus* Dogiel (1927) described four new forms, which are considered as distinct species by Kofoid and MacLennan (1933) One new species, *O spinosus*, has been described by the latter from *Bos indicus*, thus bringing the total number of species in the genus to nine

The size and position of the membranelle zones are most important characteristics of the genus The adoral zone is relatively small and inclined ventrally and to the left The dorsal membranelle zone is elongated and shifted posteriorly, so that it forms a median girdle around three-quarters of the circumference of the body The main skeletal complex is composed of three long skeletal plates lying beneath the right ventral side of the body The three plates are shaped anteriorly as in *Epidinium*, and partly surround and support the oral region The dorsal plate terminates in the middle of the body, as in that genus, but the right and the ventral plates continue posteriorly to the end of the body and even extend into the main caudal spine The secondary spines also contain accessory plates The detailed structure of the caudal complex is used in specific classification The main spine may be long and slender or short and stumpy, the secondary spines may be simple or complexly furcate, and there may be one to four circlets of these The number of contractile vacuoles varies from nine to fifteen, depending on the species

Key to Indian Species

1 (2)	Body relatively slender, main caudal spine short and stumpy, two rows of accessory caudal spines, middle skeletal plate extends to the tip of the main caudal spine, contractile vacuoles ten, in two rows	[MacL, p 353 *O spinosus* Kof &
2 (1)	Body relatively stout, main caudal spine long and slender, three circlets of accessory caudal spines, middle skeletal plate does not extend to the tip of the main caudal spine, contractile vacuoles nine, in two rows	[p 354 *O tricoronatus* (Dogiel),

248 **Ophryoscolex spinosus** Kofoid & MacLennan (Pl IX, fig 6)

†*Ophryoscolex spinosus*, Kofoid & MacLennan, 1933, pp 23–5, pl 1, fig 6, fig C, 3, 4

Body relatively slender, length 1 59–2 14 times the dorso-ventral diameter All surfaces are strongly convex except the middle of the ventral side, which is slightly concave, and the anterior two-thirds of the left ventral side, which is nearly plane Body divided into seven sectors by shallow longitudinal grooves, two of them being designated as the skeletal sector and the macronuclear sector owing to the organelles contained within them Oral area inclined ventrally and to the left. The dorsal zone arises near the dorsal skeletal plate at the level of the anterior end of the macronucleus, extends to the left and posteriorly, terminating near the ventral skeletal

plate at the level of the micronucleus There are two caudal circlets of spines, anterior composed of simple or occasionally bifurcate spines, posterior composed of bifurcate or trifurcate spines Main caudal spine short, with two small accessory spines on its dorsal side and one on its ventral side Cuticle with fine longitudinal striations The main skeletal complex composed of three adjacent plates, as in *Epidinium*, the anterior end surrounding the oral area except on the left dorsal side The dorsal plate extends from the operculum to the level of the micronucleus, median plate from the right side of the oral area to the tip of the main caudal spine, ventral plate from the ventral side of the oral area to the base of the main caudal spine Small triangular accessory skeletal plates occur in most of the caudal spines Endoplasmic sack extends from a level just behind the oral area to the posterior end of the body Rectum narrow, with the anus lying within the anterior circlet of spines near the base of the main caudal spine Ten contractile vacuoles, arranged in pairs in each sector of the body except the skeletal and macronuclear sectors Macronucleus elongate, adjacent to the dorsal edge of the main skeletal complex Micronucleus a small ellipsoid body lying in a shallow depression of the macronucleus

Dimensions —Length 122–160 μ

Feeds on Bacteria and small Flagellates

Remarks —*O spinosus* is similar to *O purkynjei*, but with two rows of spines instead of three as in that species

Habitat —Stomach of *Bos indicus* Linn MADRAS, Coonoor

249 **Ophryoscolex tricoronatus** (Dogiel) (Fig 165)

Ophryoscolex caudatus, Eberlein, 1895, pp 247–50, pl xvi, fig 4, Guenther, 1900 *b*, pp 641–8, figs 1–6, Buisson, 1923 *b*, pp 129–fig 48, Fantham, 1926, p 568, Becker & Talbot, 1927, p 258, fig 26

Ophryoscolex caudatus tricinctus, Dogiel, 1927, p 185

Ophryoscolex caudatus forma *tricoronatus*, Dogiel, 1927, pp 199–202, figs 110, 111, Hsiung, 1931, p 38

Ophryoscolex caudatus, Kofoid & MacLennan, 1933, p 26

†*Ophryoscolex tricoronatus*, Das Gupta, 1935, p 172

Body relatively stout, length 1 65–1 70 times the dorso-ventral diameter, posterior end with a long, slender, main caudal spine and three circlets of secondary spines The anterior circlet is composed of six usually trifurcate spines, middle circlet of three to five, and the posterior circlet of three to seven spines Adoral zone relatively small and inclined ventrally and to the left Dorsal membranelle zone elongated and shifted posteriorly, forming a girdle extending three-fourths the distance round the middle of the body, and incomplete

only on the right ventral side Main skeletal complex of three plates, the dorsal one terminating in the middle of the body, the right and the ventral plates continuing to the posterior end of the body and even extending for a distance into the main caudal spine There are nine contractile vacuoles arranged in two transverse bands round the body, one band of four vacuoles, just posterior to the median girdle of dorsal membranelles, and the other of five vacuoles at the base of the anterior circlet of secondary caudal spines Macronucleus oval,

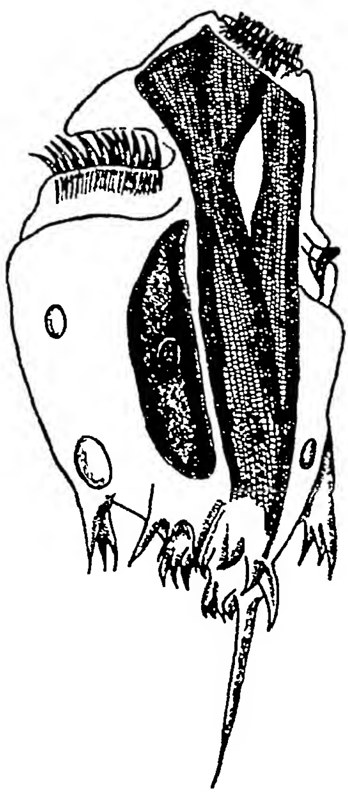


Fig 165 —*Ophryoscolex tricoronatus* (Dogiel) (After Dogiel)

pointed at either end, lying dorsal to the skeletal plates on the right side Micronucleus lies in the middle of the outer side of the macronucleus

Dimensions —Length 137–162 μ, breadth 80–98 μ, ratio of length to breadth 1 65

Remarks —This is the commonest species of the genus, and by virtue of possessing three circlets of secondary spines stands between *O bicoronatus* and *O quadricoronatus*

Habitat —Rumen of *Capra hircus* Linn BENGAL, Calcutta

General Remarks on Distribution of Ciliates in Ruminants

Extensive studies by Dogiel (1931–32) and cross-faunation experiments by Becker, Schulz, and Emmerson (1930) have shown that there is very little specificity in the relationship between these Ciliates and their hosts, though there is a certain amount of geographical segregation Dobell (1910) stated that the stomach contents of the mouse-deer, *Tragulus memmina*, from Ceylon, contained many Ciliates belonging to the Ophryoscolecidæ Jameson (1925), who studied Dobell's material, described one new species, *Entodinium ovalis*, and noted the presence of several other species which he considered to be identical with the species from European cattle, although the forms examined showed striking differences from the European forms in such characters as spination, shape of the body, and number of vacuoles According to Kofoid and MacLennan (1933) the majority of Ciliates from *Bos indicus* are found in other parts of the world, but a few are apparently found only in Asia The *Diplodinium crista-galli* group (*D læve*, *D crista-galli*, and *D flabellum*) have been found only in Persia and in India and Ceylon *Elytroplastron bubali* is found in three different hosts (*Buffelus bubalus*, *Bos indicus*, and domestic sheep) all from Asia *Entodinium bimastus*, on the other hand, has been found in three hosts (domestic cattle, *Buffelus bubalus*, and *Bos indicus*) from Asia and European U S S R

The striking differences found between the Ciliate fauna of *Bos indicus* from India and of the same host from Ceylon were that six species of *Epidinium* were found in the latter while only two were noted in the former, the single species of *Ophryoscolex*, on the other hand, was only found in two hosts from India

2 Subfamily POLYDINIINÆ Kofoid, 1935

Numerous accessory membranelle zones, extending over the considerably elongated body These zones, instead of being dorsal, are divided bilaterally into two groups which still fall into a descending right spiral both individually and in pairs Contractile vacuoles numerous, arranged in zones parallel to the membranelle zones One to three skeletal plates present

The two genera included in this subfamily exhibit a secondary bilateral symmetry superposed upon the primitive spiral one and an extension of metamerism by the added membranelle zones throughout the elongated body of these Ciliates.

Key to Indian Genera.

1 (2) Body very large, initially with five additional membranelle zones, three equal club shaped skeletal plates, extending nearly the whole length of the body, macronucleus stout, club shaped ... POLYDINIUM Kofoid, [p 357.

2 (1) Body very large, initially with six additional membranelle zones, skeletal plate single, sigmoid, confined to the anterior half of the body, macronucleus Z shaped, with enlarged ends ... ELEPHANTOPHILUS [Kofoid, p 359

Genus **POLYDINIUM** Kofoid, 1935

Polydinium, Kofoid, 1935, pp 502–4

Body oval, very large in size, with a relatively feebly developed adoral zone and five additional membranelle zones in the young state Posterior caudal lobe with accessory cilia Three equal, club-shaped, skeletal plates extending nearly the whole length of the body Contractile vacuoles twenty to thirty, distributed in irregular rows Macronucleus stout, club-shaped, on the left side of the skeletal plates near the middle of the body

250 **Polydinium mysoreum** Kofoid (Fig 166)

†*Polydinium mysoreum*, Kofoid, 1935, pp 502–4, figs 1–3

Body oval, very large in size, anterior end truncated and broader than the posterior end Caudal lobe with an accessory group of cilia on its dorsal face and containing an irregular mass of stored material in a vacuole in the ectoplasm Adoral spiral of membranelles makes a single turn and is relatively feebly developed, it leads directly into the well-developed but narrow œsophagus, which is laterally compressed and continues posteriorly for two-thirds of the length of the body, opening there in the endoplasm Rectum short and wide, opening by a large oval anal opening situated in front of the posterior lobe In addition to the adoral zone there are, to begin with, five additional membranelle zones, which increase to seven during early stages of growth, and ultimately to ten, prior to binary fission These zones are divided bilaterally into two groups and run in a descending right spiral both individually and in pairs There are three equal club-shaped, double-layered, skeletal plates running nearly the whole length of the body surrounding the œsophagus These plates are crowned by the œsophageal neuromotor ring with deeply staining enlargements at the nodes (fig 166, *c*) Contractile vacuoles twenty to thirty, distributed in irregular

rows posterior to each of the pairs of accessory membranelle zones Macronucleus stout, club-shaped, lying on the left side of the skeletal plates near the middle of the body, with a micronucleus embedded in its ventral side

Dimensions —Length 200–250 μ

Feeds on plant débris, Bacteria, and Flagellates

Habitat —In the cæcum and colon of the Indian elephant, *Elephas indicus* Cuvier MADRAS, Nilgiri Mountains

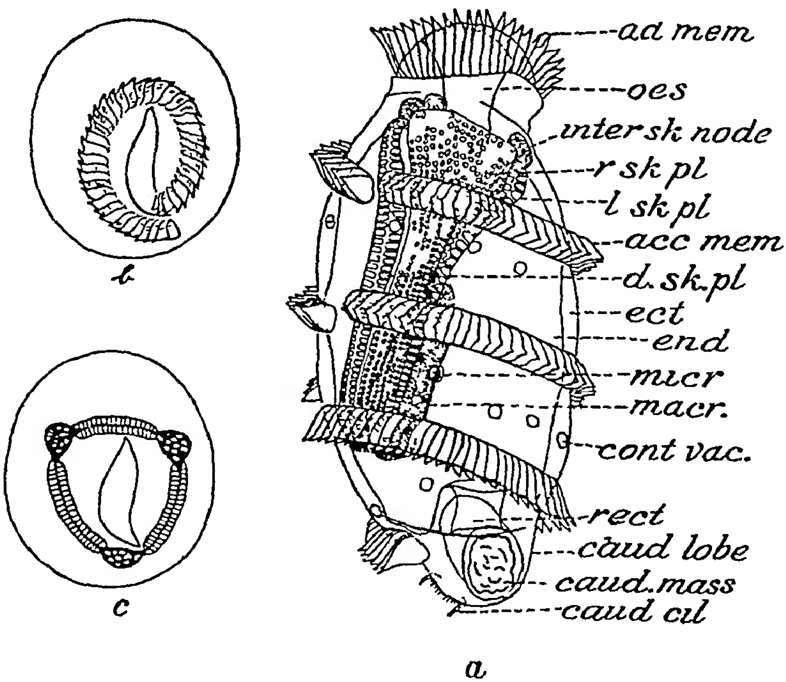


Fig 166 —*Polydinium mysoreum* Kofoid *a*, right view, *b*, cross section, showing œsophagus and adoral membranelle zone, *c*, oblique section through anterior ends of the skeletal plates, showing their bilaminate structure, circumœsophageal neural ring, and two dorsal and one ventral interskeletal nodes *acc mem*, accessory membranelle zone, *ad mem*, adoral membranelles, *caud cil* caudal cilia, *caud lobe*, caudal lobe, *caud mass*, caudal mass, *cont vac*, contractile vacuole, *d sk pl*, dorsal skeletal plate, *ect*, ectoplasm, *end*, endoplasm, *intersk node*, interskeletal node of œsophageal neural ring, *l sk pl*, left skeletal plate, *macr*, macronucleus, *micr*, micronucleus, *oes*, œsophagus, *r sk pl*, right skeletal plate, *ect* rectum (After Kofoid)

Genus **ELEPHANTOPHILUS** Kofoid, 1935

Elephantophilus, Kofoid, 1935, p 504

Body oval, very large in size, with an adoral zone and six additional membranelle zones in the young state Posterior caudal lobe with accessory cilia Skeletal plate single, sigmoid, confined to the anterior half of the body Contractile vacuoles numerous, distributed in irregular rows Macronucleus Z-shaped, with enlarged ends

251 **Elephantophilus zeta** Kofoid (Fig 167)

†*Elephantophilus zeta*, Kofoid, 1935, p 504, figs 4, 5

Body oval, very large in size, anterior end broadly truncated, posterior end narrower and smoothly rounded Caudal lobe

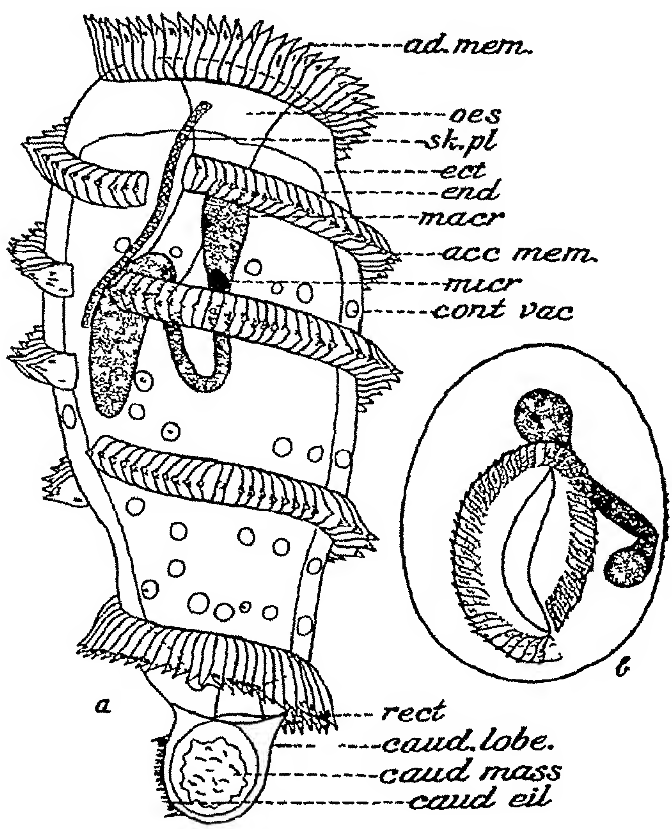


Fig 167 —*Elephantophilus zeta* Kofoid *a*, right view, *b*, cross section, showing œsophagus with optical projection of adoral membranelle zone and macronucleus Lettering as in the previous figure (After Kofoid)

with an accessory group of cilia on its dorsal face and containing an irregular mass of stored material in a vacuole in the ectoplasm Adoral membranelle zone relatively feebly developed Œsophagus much wider and shorter than in *Polydinium* and lacking the skeletal support In addition to the adoral zone there are six seriated accessory membranelle zones in the young stage, increasing to twelve prior to binary fission These are arranged in bilateral pairs in a descending right spiral and impart a secondary bilateral symmetry Skeletal plates are reduced to a single one, composed of one linear row of prismatic chambers forming a sigmoid line on the right dorsal side in the anterior half of the body Contractile vacuoles numerous, distributed in irregular rows posterior to the accessory membranelle zones The macronucleus, viewed laterally, has the form of a flattened letter Z, with enlarged ends, and has the micronucleus embedded in the anterior lobe on the right face, viewed dorsally it presents a slightly flattened spiral form

Dimensions —Length 250–290 μ

IV. Suborder *CTENOSTOMIDA* Lauterborn (=Ctenostomata Kahl)

Small laterally flattened Ciliates with elongated cilia confined to a few rows or groups, especially at the posterior end Both the frontal and the posterior end of the body are provided with teeth-like processes Near the anterior end is situated a transversely running frontal band, thickly provided with cilia arranged in five rows Mouth with a peculiar comb-like structure, the teeth of which are cirri-like structures The adoral zone is limited to eight membranelles, which are situated in a groove opening ventralwards Pellicle is strengthened with armour-plates Almost exclusively sapropelic in foul muddy water

Identification Table of Families

1 Posteriorly the coat of mail is open Ciliation relatively strong Right lateral surface with at least two, left lateral surface with four posterior and one frontal row	**Epalcidæ** * Wetzel
2 Posteriorly the coat of mail is slightly open or wholly closed Ciliation weak Generally the left lateral surface only provided posteriorly with one or two short rows of cirri like fused longer cilia Frontal band limited to the narrow ventral side	**Mylestomidæ** * Kahl

3 Posteriorly the coat of mail is closed Ciliation weak Frontal band extends to a strong swelling on both lateral surfaces, on the left as a wide unbroken stretch, right lateral surface with a stronger posterior spine directed ventralwards — Discomorphidæ * Kahl

Up to the present time no animals belonging to any of the families in this suborder have been discovered in India

Remarks—As CTENOSTOMATA is preoccupied as a name for a suborder of Polyzoa, the name of the suborder should be CTENOSTOMIDA

V. Suborder *HYPOTRICHA* Stein.

The suborder HYPOTRICHA includes some of the most highly differentiated forms among the Protozoa They are generally flattened dorso-ventrally, and the motile organs are confined to the ventral surface In the less differentiated forms (family Peritromidæ) there are numerous cilia of uniform size arranged in rows on the ventral surface In others the cilia are reduced in number and there are groups of cirri which are believed to be formed by fusion of adjacent cilia The cirri are located in regional groups known as frontals, ventrals, anals, marginals and caudals Among the Urostylinæ, frontal and anal cirri are differentiated and the rest of the ventral surface is covered with uniform cilia In the Pleurotrichinæ and Psilotrichinæ the cirri are increased and ventral cilia further reduced or even absent In Euplotidæ and Aspidiscidæ the ventral cilia are entirely replaced by cirri, and marginal cirri are greatly reduced or absent On the dorsal surface the cilia are changed into stiff tactile bristles, which are arranged in rows and recognizable with difficulty Peristome lies ventrally at the anterior end of the body The adoral zone of membranelles, after going round the anterior end of the body, runs along the left margin of the triangular peristomial field Along the right margin of the peristomial field and in the peristomial field itself there are one or more undulating membranes or ciliary rows named as preoral, adoral, paroral, etc, according to their position in relation to the mouth (see fig 168)

There are usually two macronuclei and two micronuclei Conjugation and encystment occur in all forms Cysts are frequently ornamented by numerous spines

The great majority of the HYPOTRICHA live in fresh water and are bottom feeders, showing a great variety of swimming,

creeping or springing movements Many of them (e g, *Stylonychia*) walk or run on the tips of their frontal and ventral cirri, others (e g, *Aspidisca*) swim with a peculiar jerky movement, while still others (e g, *Uronychia, Euplotes*) combine swimming due to the adoral zone with sudden springs

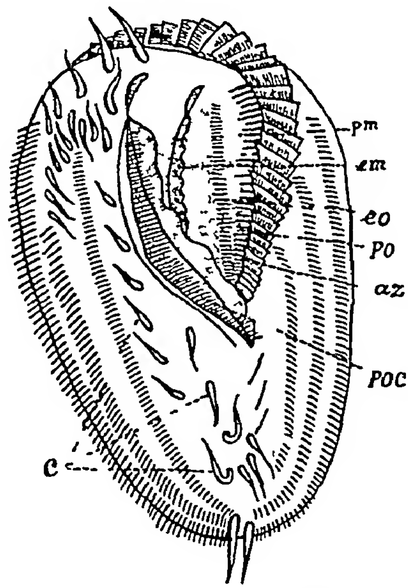


Fig 168 —Diagram of a Hypotrichous Ciliate *az*, adoral zone of membranelles, *c*, ventral and anal cirri, *em*, endoral membrane, *eo*, endoral cilia, *pm*, paroral membrane, *po*, preoral cilia, *poc*, paroral cilia (After Calkins)

or jumps due to the anal or caudal cirri A few of them (e g, *Stichotricha*) dwell in tubes, and one genus (*Kerona*) is found as an ectoparasite on *Hydra*

Identification Table of Families

1 (2)	Ventral surface bearing cilia only, no cirri	Peritromidæ St, p 363
2 (1)	At least anal cirri on ventral surface	3
3 (4)	Ciliation on the ventral surface thick and tolerably uniform, or, when reduced, limited to a few longitudinal rows Two uninterrupted marginal rows always present	Oxytrichidæ Ehrbg, [p 365
a	At least two uninterrupted rows of ventral cilia present, no ventral cirri posterior to mouth except anals	Urostylinæ, p 365
b	Ventral rows interrupted, of their cilia only some changed into cirri, five to eight frontal cirri	Pleurotrichinæ, [p 371
c	One or two ventral rows of bristle shaped cirri, in part irregularly situated, no ventral cilia	Psilotrichinæ, p 382

4 (3)	Ventral cilia entirely replaced by cirri, marginal cilia greatly reduced or absent	5
5 (6)	A few marginal cirri present on the sides of the body or at the posterior end, frontal, ventral and anal cirri present	[p 384 Euplotidæ Ehrbg,
6 (5)	Marginal rows completely absent, variable frontals, ventrals and anals	[p 388 Aspidiscidæ Ehrbg,

1 Family PERITROMIDÆ Stein, 1867

Flattened forms with uniform coating of undifferentiated cilia on the ventral surface The adoral zone of membranelles surrounds the anterior end of the body and runs along the left margin of the peristome

Kahl (1930–5) has transferred this family to HETEROTRICHA, and restricted HYPOTRICHA to include only those forms in which some of the ventral cilia are modified into cirri In my opinion, in the structure of the adoral zone and in the possession of a double macronucleus the family shows undoubted resemblance to the other HYPOTRICHA, and should not be separated from them

Genus **PERITROMOIDES**, gen nov

Animalcules free-swimming, large, ovate, depressed Peristomial field extends backwards to the middle of the ventral surface and possesses a fringe of large, powerful adoral membranelles surrounding the anterior end of the body and extending along the left border of the peristome, and an undulating membrane extending along the right border of the peristome Peristome followed by a narrow cytopharynx No ventral or anal styles or setæ, the ventral surface bearing interrupted but parallel rows of fine vibratile cilia Macronucleus double Inhabiting fresh water

252 **Peritromoides simplex,** sp nov (Fig 169)

Body ovate, widest in the posterior half, about one and a half times as long as broad, with a small triangular tail-like projection at the posterior end of the body Peristomial field wide, gradually narrowing posteriorly, with a fringe of stout and powerful adoral membranelles along its left border and around the anterior margin of the body and an undulating membrane along the right margin of the peristome From the posterior end of the peristome a narrow and tapering

cytopharynx extends to middle line of the body Ventral surface provided with obliquely running, parallel rows of cilia, four rows in the anterior half and only three in the posterior half, with bunches of similar cilia in slight indentations of the margins of the body, short marginal cilia also present except at the anterior extremity of the body Contractile vacuoles two, one slightly to the left of the posterior end of the peristomial groove, the other situated to the right of the groove in the anterior half of the body Macronucleus double, the two halves widely separated

Dimensions —Length 136 μ

Remarks —This form was met with in water from a pond in Lahore It measured 136 μ in length, and its greatest width was 90 μ The form was flattened and showed a certain degree of resemblance with Oxytrichinæ in possessing an

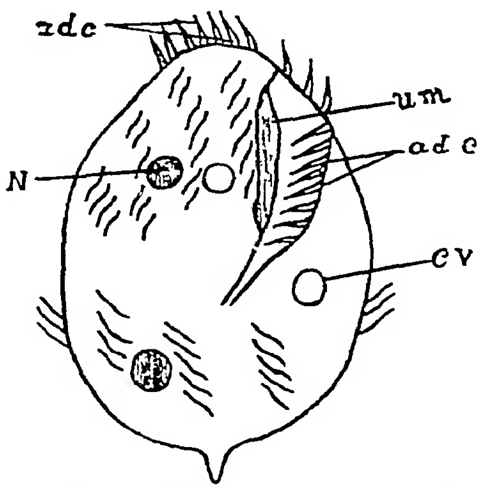


Fig 169 —*Peritromoides simplex*, sp nov *ad c*, adoral zone of membranelles, *C V*, contractile vacuole, *N*, nucleus, *u m*, undulating membrane

edentulate cytopharynx, an excavate peristomial field, and a fringe of adoral membranelles It differed from the latter however, in the complete absence of any ventral or anal styles or setæ and in possessing rows of ordinary cilia on the ventral surface It differs from *Peritromus* in that the cilia of the ventral surface are not uniformly and densely arranged, but occur in oblique and interrupted rows Other points of difference that may be mentioned are the existence of an undulating membrane along the right peristomial border and the occurrence of two contractile vacuoles The body of the organism was remarkably clear and transparent, there being only a few green corpuscles and other food vacuoles present

While *Peritromus* shows close-set rows of ventral cilia of uniform size, *Peritromoides* shows an even nearer approach to the Oxytrichidæ by the reduction of both marginal and ventral cilia and the possession of an undulating membrane along the right peristomial border Both are flattened and possess an adoral zone of membranelles and the double macronucleus

Habitat —Fresh water PUNJAB, Lahore

2. Family OXYTRICHIDÆ Ehrenberg, 1838

Flattened forms with thick and tolerably uniform ciliation on the ventral surface, or, when this is reduced, cilia are limited to a few longitudinal rows With the reduction in the ventral cilia there is a corresponding increase in the number and complexity of the cirri Anal cirri at least are always developed Two uninterrupted marginal rows are always present Adoral zone of membranelles is well developed Dorsal bristles are present

The family is divided into three subfamilies—Urostylinæ, Pleurotrichinæ, and Psilotrichinæ

1 Subfamily UROSTYLINÆ Butschli, 1889

At least two uninterrupted rows of ventral cilia present Frontal and anal cirri generally distinct Apart from these ventral cilia are not changed into cirri

Key to Indian Genera

1 (4)	Distinct anal cirri present	2
2 (3)	Two rows of marginal, five to seven rows of ventral cilia	[p 366 UROSTYLA Ehrbg,
3 (2)	Two rows of marginal, two to three rows of ventral cilia	[em Entz, p 367 HOLOSTICHA Wrzes
4 (1)	Without distinct anal cirri	5
5 (6)	Posterior end not drawn out into a tail Ventral ciliary rows oblique, without frontal or anal cirri Body anteriorly drawn out into a neck Peristome long Often tube dwelling	[p 368 STICHOTRICHA Perty,
6 (5)	Posterior end distinctly drawn out into a tail Two rows of ventral cilia, three frontal cirri, no anal cirri, no long caudal cilia or bristles	[em St, p 369 UROLEPTUS Ehrbg

Genus **UROSTYLA** Ehrenberg, 1830

Urostyla, Ehrenberg, 1830, p 43 1838, p 369, Stein, 1859 *d*, p 191, 1867, p 63, Claparède & Lachmann, 1858–61, p 168, Kent, 1880–2, p 764, Butschli, 1887–9, p 1741, Roux, 1901, p 95, Lepsi, 1926 *a*, p 81, Schoenichen, 1927, p 228, Reichenow, 1929, p 1206, Kahl, 1930–5, p 564, Calkins, 1933, p 519

Body egg-shaped, elongated, very flexible, often coloured yellow or brown Peristome more or less elongated, not extending beyond the middle of the body, breadth very variable Mouth provided with two undulating membranes and three ciliary rows Marginal, frontal (three or more) and anal (5 to 12) cirri well developed Numerous rows of ventral cilia or setæ arranged in longitudinal rows Caudal setæ absent Contractile vacuole to the left, near the posterior angle of the peristome Macronucleus single or multiple Often with zoochlorellæ Locomotion moderately brisk

253 **Urostyla weissii** Stein (Fig 170)

Oxytricha urostyla (?), Claparède & Lachmann, 1858, pp 141–2, pl v, fig 2
Oxytricha multipes (?), Claparède & Lachmann, 1858–61, pp 143–4, pl v, fig 1
Urostyla weissii, Stein, 1859 *d*, pp 192–4, pl xiii, figs 1–4, Kent, 1880–2, pp 764–5
†*Urostyla weissii*, Gulati, 1925, p 752, fig 22
'*Urostyla weissii*, Lepsi, 1926 *a*, p 84, fig 430, Schoenichen, 1927, pp 228–9, pl xiii, fig 4
Urostyla weissei, Reichenow, 1929, p 1206, fig 1188 A, Kahl, 1930–5, p 568, fig 97, *4*

Body elongate-elliptical, about three and a half times as long as broad, widest centrally, gradually tapering towards the two extremities, anterior end the narrower Peristomial field forming an acute triangle, extending to a little beyond the anterior third of the body, its reflected border ciliate, nearly straight Three to five frontal styles, supplemented by five even median rows of short ventral setæ, marginal setæ forming a continuous projecting row, anal styles seven to eight Contractile vacuole single, subcentral Macronucleus ovate, double Micronucleus not distinguished Body yellowish or brownish

Dimensions —Length 280–297 μ

Remarks —Gulati mentions that in the form examined by him the macronucleus was broken up into many small oval bodies

Habitat —Pond water PUNJAB, Lahore

Fig 170

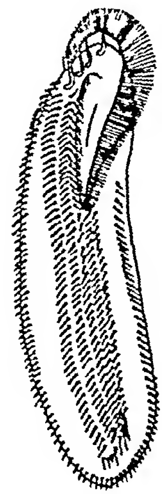


Fig 171

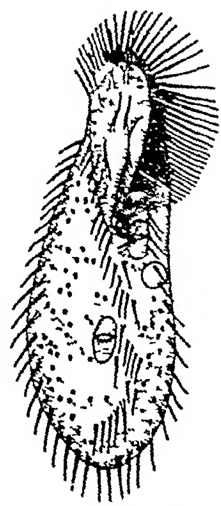


Fig 170 —*Urostyla weissii* Stein (After Stein)
Fig 171 —*Holosticha mystacea* (Stein) (After Stein)

Genus HOLOSTICHA Wrzesniowski, 1877, emend Entz, 1884

Holosticha, Wrzesniowski, 1877, p 278, Kent, 1880–2, p 769, Entz, 1884, pp 360–7, Bütschli, 1887–9, p 1744, Kahl, 1930–5, p 578, Calkins, 1933, p 519

Body free-swimming, more or less elastic, and changeable in form, oval or elongate, not drawn out into a neck or tail Frontal cirri absent, two or three uninterrupted rows of short ventral setæ which extend over frontal area also, five or more anal styles and a continuous projecting border of marginal setæ Contractile vacuole single, spherical, usually occupying a median position close to the left margin Macronucleus double Inhabiting salt and fresh water

254. Holosticha mystacea (Stein) (Fig 171)

Oxytricha mystacea, Stein, 1859 *d*, pp 188–9, pl xii, figs 7–11
Holosticha mystacea, Kent, 1880–2, p 769, pl xliii, fig 11
†*Oxytricha mystacea*, Daday, 1898, p 8
Gastrostyla mystacea, Lepsi, 1926 *a*, p 85, fig 455, Schoenichen 1927, p 234
Holosticha mystacea, Kahl, 1930–5, p 585, fig 106, *25*

Body ovate, flattened, nearly three times as long as broad, rounded and widest posteriorly, right side convex, left concave Peristomial field extending backwards nearly to the centre of the body, its reflected border arcuate, distinctly ciliate Ventral setæ forming two irregular, curved, central

rows, supplemented anteriorly with a few additional styles, marginal setæ constituting a continuous projecting border, the posterior ones longest, anal styles of medium size, not projecting beyond the posterior margin Contractile vacuole single, spherical, median Macronucleus double

Dimensions —Length 131–173 μ

Habitat —Pond water CEYLON, Kandy

Genus STICHOTRICHA Perty, 1849

Stichotricha, Perty, 1849, p 169, Stein, 1859 *d*, p 174, 1867, p 149, Kent, 1880–2, p 775, Butschli, 1887–9, p 1743, Roux, 1901, p 96, Lepsi, 1926 *a*, p 81, Schoenichen 1927, p 230, Kahl, 1930–5, p 556, Calkins, 1933, p 517

Body spindle-shaped but very variable in form, colourless or green Anterior end strongly narrowed and flattened, forming a more or less elongated and contractile neck Peristome long and narrow, slit-like, with very long adoral cilia that are constantly surging up and down, extending to the middle of the body Marginal cilia well developed, commencing on the left margin behind the peristome and on the right margin near the summit of the narrow part Varying number of rows of ventral cirri Without frontal or anal cirri The narrow anterior end carries on either side a row of larger dorsal bristles Macronucleus in the form of two oval bodies Locomotion irregular

255 **Stichotricha** sp (Fig 172)

†*Stichotricha* sp, Chaudhuri, 1929, p 54, pl ii, fig 21

Remarks —The form figured by Chaudhuri resembles in all essential respects *S aculeata* Wrzesn, except that the two rows of ventral cirri are not shown

Fig 172 —*Stichotricha* sp (After Chaudhuri)

Habitat —Soil from CENTRAL INDIA, Indore

Genus UROLEPTUS Ehrenberg, 1831, emend Stein, 1859

Uroleptus, Ehrenberg, 1831, p 116, 1833, p 277, 1838, p 358, Stein, 1859 *d*, p 176, Claparède & Lachmann, 1858–61, p 151, Engelmann, 1862, p 386, Kent, 1880–2, p 779, Butschli, 1887–9, p 1745, Roux, 1901, p 98, Lepsi, 1926 *a*, p 81, Schoenichen, 1927, p 231, Sandon, 1927, p 192, Kahl, 1930–5, p 547, Calkins, 1933, p 517

Body elongated, posteriorly with a tail-like prolongation, variable or constant in form, colourless, red, or violet In addition to the well developed marginal cilia there are two rows of ventral cilia, lying close to one another Three frontal cirri present, anal cirri and caudal setæ absent Peristome of varying length and breadth Contractile vacuole to the left of the middle All species live in stagnant water Locomotion rapid, incessant, frequently changing in direction Feed on detritus, Algæ, Diatoms, etc

Key to India Species

1	Body not pear shaped, but narrow, elongated, spindle shaped	2
2 (3)	Marginal cilia longer posteriorly Body anteriorly widened Length up to 140 μ	[Ehrbg, p 370 *U piscis* (Mull)
3 (2)	Marginal cilia uniform Body not widened anteriorly Length 350–400 μ	[p 369 *U mobilis* Engelm ,

256 **Uroleptus mobilis** Engelmann (Fig 173)

Uroleptus mobilis, Engelmann, 1862, p 386, pl xxxi, figs 11, 12, Kent, 1880–2, p 781, pl xliii, figs 9, 10, Roux, 1901, p 99, pl vi, fig 2, Lepsi, 1926 *a*, p 84, fig 439, Schoenichen, 1927, p 232, pl xiii, fig 9

†*Uroleptus mobilis* (?), Sandon, 1927, p 193

†*Uroleptus mobilis*, Chaudhuri, 1929, p 54, pl ii, fig 26

Uroleptus mobilis, Kahl, 1930–5, p 548, fig 101, 2, Calkins, 1933, pp 27, 28, 58, 63, 84, 219, 220, 245, 251, 254, 267, 313, 334, figs 1, 27, 32, 109, 127, 128, 129, 131, 137, 159, 160, 166

Very narrow, about twelve times as long as broad, posterior end tapering to a blunt point, body cylindrical and contractile Peristome very narrow, exceedingly small, extending to about one-ninth of the length of the body, its inner border with an undulating membrane Frontal styles uncinate, three in number, some scattered ventral cirri, marginal setæ relatively long and widely spaced Contractile vacuole near the left margin, in front of the middle of the body Macronucleus consisting of six ovoid masses arranged in a longitudinal row

Dimensions —Length 350–400 μ, breadth about 40 μ

Fresh water and in soil

Habitat.—Doubtfully recorded by Sandon in soil from MADRAS, Coimbatore, and by Chaudhuri in soils from KASHMIR, Srinagar; PUNJAB, Ghora Gali; DELHI; CENTRAL INDIA, Indore; BENGAL, Chittagong; BURMA, Rangoon.

257. **Uroleptus piscis** (Muller) Ehrenberg. (Fig. 174.)

Trichoda piscis, Muller, 1773, p. 73; 1786, p. 214, pl. xxxi, figs. 1–4.
Uroleptus piscis, Ehrenberg, 1838, p. 358, pl. xl, fig. 1.
Oxytricha caudata, Ehrenberg, 1838, p. 365, pl. xl, fig. 11; Claparède & Lachmann, 1858, p. 146, pl. v, fig. 7.
Uroleptus piscis, Kent, 1880–2, p. 780, pl. xliii, fig. 21.
Uroleptus (*Amphisia*) *piscis*, Butschli, 1887–9, pl. lxxi, fig. 2.
Uroleptus piscis, Roux, 1901, p. 99, pl. vi, fig. 3; Lepsi, 1926 *a*, p. 84, fig. 435; Schoenichen, 1927, p. 232, pl. xiii, fig. 8.
†*Uroleptus piscis*, Sandon, 1927, p. 193; Chaudhuri, 1929, p. 60.
Uroleptus piscis, Kahl, 1930–5, p. 550, fig. 101, *1*; Calkins, 1933, pp. 151, 518, figs. 81, 209 B.

Body exceedingly elastic and somewhat variable in shape, broadly linear-fusiform or band-like, from six to eight times

Fig. 173.

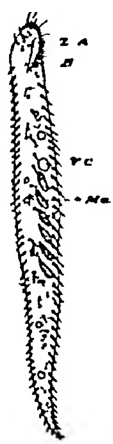


Fig. 174.

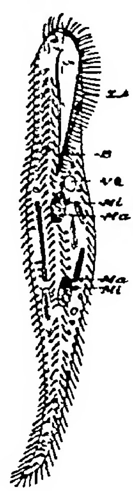


Fig. 173.—*Uroleptus mobilis* Engelmann. *B*, cytostome; *Ma*, macronucleus; *Mi*, micronucleus; *V.C.*, contractile vacuole; *Z.A.*, adoral zone. (After Roux.)
Fig. 174.—*Uroleptus piscis* (Muller) Ehrenberg. Lettering as in the previous figure. (After Roux.)

as long as broad, anterior end rounded, maximum width about the middle, with a long strap-like tail ending in a blunt point and turning to the right. Peristome extending from one-fourth to one-third of the length of the body; adoral zone well developed along the anterior and left margin, right margin with a narrow undulating membrane and fine preoral cilia. Frontal cirri three, marginal setæ set on ventral

surface but projecting beyond the edge all along the body, rather longer on the tail, ventral setæ in two median rows Contractile vacuole near the left margin, in front of the middle of the body Macronucleus consisting of two ovoid masses, situated in the middle part of the body behind the contractile vacuole

Dimensions—Length 600–800 μ, maximum breadth 80–110 μ

Fresh water and in soil

Habitat—Soils from KASHMIR, Srinagar, CENTRAL INDIA, Indore, MADRAS, Coimbatore

258 **Uroleptus** sp

†*Uroleptus* sp, Chaudhuri, 1929, p 54, pl iii, figs 3, 4

Habitat—Soils from N W F PROVINCE, Peshawar, CENTRAL INDIA, Indore

2 Subfamily PLEUROTRICHINÆ Butschli, 1889

Ventral cilia in interrupted rows, some of them being changed into cirri Frontal cirri distinctly developed, typically eight in number Anal cirri invariably present One or two rows of marginal cilia also present

Key to Indian Genera

1	Eight frontal cirri arranged in a typical manner	2
2 (3)	Peristome narrow, elongated, bent at an angle about the middle of the body. three caudal cirri	GONOSTOMUM Sterki, [p 372
3 (2)	Peristome broad or narrow, not bent at an angle in the middle of the body	4
4 (7)	Besides the fine, strongly developed ventral cirri there are rows of smaller cirri, or altogether only one or two rows of but slightly differentiated ventral cirri Peristome broadly triangular	5
5 (6)	Eight frontal cirri, five differentiated ventral cirri, row of anal cirri broken, two near posterior end, no caudals, marginal row of cilia unbroken posteriorly	PLEUROTRICHA Stein, [p 373.
6 (5)	Eight frontal cirri, the three anterior being more conspicuously developed, ventral setæ forming an oblique row, occasionally supplemented by a few others, four or five anals well developed, marginal row of cilia unbroken posteriorly	GASTROSTYLA Engelm, [p 377.

7 (4)	Only five ventral cirri Peristome large, often extending to the middle of the body	8
8 (9)	Eight frontal and five ventral cirri, two of the latter near the peristome, two near the anals, and one median, five well-developed anal cirri, without caudal cirri	[em Sterki, p 378 OXYTRICHA (Ehrbg)
9 (8)	As above, but marginal cirri interrupted posteriorly, three caudal cirri	[em Stein, p 380 STYLONYCHIA (Ehrbg)

Genus **GONOSTOMUM** Sterki, 1878

Oxytricha, part, Stein, 1859 *d*, p 182
Gonostonum, Sterki, 1878, p 57
Plagiotricha, part, Kent, 1880–2, p 772
Gonostomum, Maupas, 1883 *a*, pp 550–6, Bütschli, 1887–9, p 1748, Lepsi, 1926 *a*, p 82, Schoenichen, 1927, p 234, Kahl, 1930–5, p 597, Calkins, 1933, p 519

Body form mostly narrow, narrow and pointed at both extremities Peristome very narrow, with its posterior extremity bent abruptly inwards, and terminating near the centre of the body Eight frontal styles, one or more oblique rows of ventral setæ, a projecting fringe of marginal setæ, and four or five anal styles Generally with three distinct caudal setæ Contractile vacuole single, near the left lateral border Macronucleus bipartite

259 **Gonostomum affine** (Stein) (Fig 175)

Oxytricha affinis, Stein, 1859 *d*, pp 186–7, pl xii, figs 1–6
Plagiotricha (*Gonostomum*) *affinis*, Kent, 1880–2, p 772, pl xliii, fig 25
Gonostomum affine, Butschli, 1887–9, pl lxxi, fig 8, Lepsi, 1926 *a*, p 86, fig 457, Schoenichen, 1927, p 234, pl xiii, fig 13
†*Gonostomum* (*Plagiotricha*) *affine*, Sandon, 1927, p 195, pl vi, fig 15, pl i, fig 25
†*Gonostomum affine*, Chaudhuri, 1929, p 60, pl ii, figs 29, 30, pl iv, fig 17
Gonostomum (*Oxytricha*) *affine*, Kahl, 1930–5, p 598, fig 113, *9*, fig 115, *1–4*

Body elongated oval, three and a half to four times as long as broad, ends narrowed and equally rounded, in section almost circular, very flexible Peristome very narrow, reaching to the middle of the body, running back for the greater part of its length parallel to the axis of the body and making a very characteristic sharp bend inwards near its hind end Cilia of the adoral zone uniformly elongated Eight frontal cirri, five or six ventral cirri arranged in an oblique row, marginal cirri uninterrupted at the posterior end, where they are a little longer, anal styles five, short and inconspicuous, not reaching

to the posterior extremity of the body, no caudal setæ Contractile vacuole near the left margin, about the middle. Macronucelus in two rather elongated ovoid masses Cyst has a thin smooth wall

Dimensions —Length 75–100 μ Diameter of cyst 33 μ

In swampy water and a very common soil form

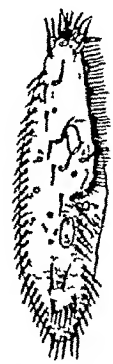


Fig 175 —*Gonostomum affine* (Stein) (After Sandon)

Habitat —Sandon records it from soil from spice-gardens SOUTHERN INDIA, Kanara, and doubtfully records it from soils from PUNJAB, Jullundur, MADRAS, Coimbatore Chaudhuri records it from soils from KASHMIR, Srinagar, PUNJAB, Lahore, DELHI, UNITED PROVINCES, Agra, BOMBAY, Dharwar, CEYLON, Colombo

260 **Gonostomum** sp

†*Gonostomum* sp, Chaudhuri, 1929, p 54, pl iii, figs 5, 6

Remarks —This form has been imperfectly described and poorly figured It is doubtful if it is a species of *Gonostomum* at all

Habitat —From soils from PUNJAB, Lahore, BENGAL, Dacca, and MADRAS, Madras

Genus **PLEUROTRICHA** Stein, 1859

Pleurotricha, Stein, 1859 *a*, p 4, 1859 *d*, p 168, Engelmann, 1862, p 385, Kent, 1880–2, p 782, Butschli, 1887–9, p 1747, Lepsi, 1926 *a*, p 82, Schoenichen, 1927, p 233, Reichenow, 1929, p 1207, Kahl, 1930–5, p 593

Free-swimming, medium-sized, persistent in form, elongate or elliptical Peristome-field broad, triangular, not extending to the median line, with both undulating membranes well developed Eight frontal cirri, the three anterior of which are usually more conspicuously developed, arranged in a

typical manner Five large ventral cirri, together with one or more complete rows of smaller ventral setæ Anal styles five or six, arranged in two groups, of which one, containing the two on the right side, is situated close to the posterior end, whilst the other, consisting of the three on the left side, is situated further forwards on a level with the last of the ventral cirri Caudal styles absent Contractile vacuole situated near the posterior angle of the peristome Macronucleus ovate, sometimes multiple Locomotion swift, almost springing, changing in direction to left and right Inhabiting fresh water

Key to Indian Species

1 (2) Body broad, egg shaped Two or more, usually three, rows of ventral cirri on either side of the median group of ventral uncini ... *P grandis* Stein, p 374

2 (1) Body lanceolate One complete and one incomplete row of ventral cirri on the right side only of the median group of ventral uncini ... [Stein, p 376 *P lanceolata* (Ehrbg)

261 **Pleurotricha grandis** Stein (Fig 176)

Pleurotricha grandis, Stein, 1859 *a*, p 4, 1859 *d*, pp 169–70, pl x, fig 1, Kent, 1880–2, p 782, Butschli, 1887–9, p 1248, fig 6, pl lxxi, fig 5

†*Pleurotricha grandis*, Bhatia, 1920, p 262, Gulati, 1925, p 10, fig 23

Pleurotricha grandis, Lepsi, 1926 *a*, p 85, fig 452, Schoenichen, 1927, p 233, pl xii, fig 11

†*Pleurotricha grandis* (?), Sandon, 1927, p 197, Chaudhuri, 1929, p 54.

Pleurotricha grandis, Reichenow, 1929, p 1207, fig 1188 B, Kahl, 1930–5, p 593, fig 113, *3*

Body elliptical, about twice as long as broad, widest a little behind the middle Peristome not extending to the middle Eight frontal cirri arranged in a typical manner, five ventral uncini stout and subcentral, supplemented on each side by usually three parallel rows of smaller ventral setæ, anal styles in two subgroups, the two together constituting one group, removed towards the posterior extremity and projecting to a considerable distance beyond its margin Contractile vacuole close to the posterior angle of the peristome

Dimensions —Length 100–420 μ

Fresh water among aquatic plants

Remarks —The size of this species is apparently subject to considerable variation The form met with at Lahore measured only 100 μ in length and 40 μ in its greatest width Schoenichen gives the length as 100–200 μ, Kent 208–416 μ, Sandon 210–420 μ The number of supplementary rows of

small ventral setæ also shows considerable variation Kent mentions two parallel rows of smaller ventral setæ on each side Stein, Butschli, and Schoenichen show three rows on each side Lepsi states that there are some five rows, of which in his figure three are shown on the right and two on the left Sandon gives two complete and one partial row on either side of the median group Gulati mentions one or more rows on each side In the specimens examined by me at Lahore I found on one occasion five rows on the right side and only three rows on the left, and on another only two rows on each side

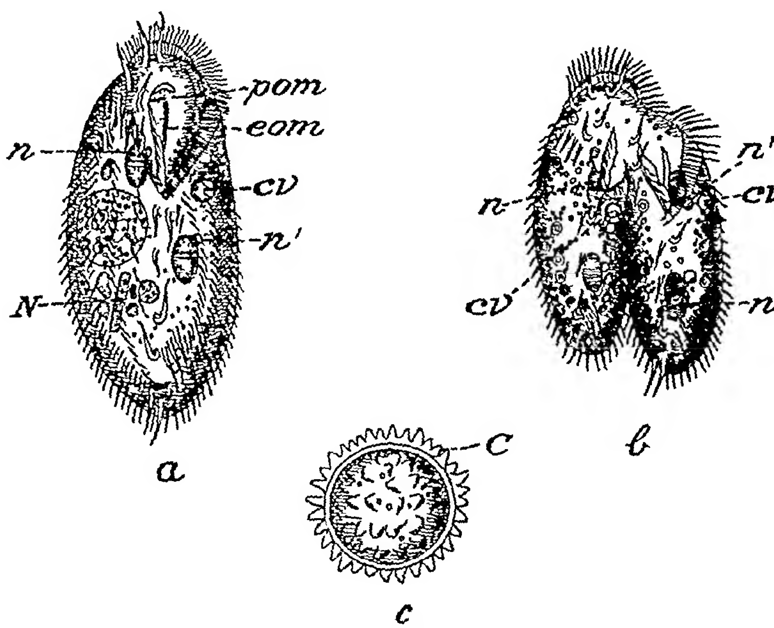


Fig 176 —*Pleurotricha grandis* Stein *a*, ventral view, *b*, conjugation, *c*, cyst *C*, cyst, *cv*, contractile vacuole, *eom*, endoral membrane, *n*, macronucelus, *n'*, micronucleus, *N*, food-particle, *pom*, postoral membrane (After Butschli)

Transverse fission was observed in this form The anterior part of the body containing the peristome narrowed somewhat, some of the bristles were cast off, another contractile vacuole developed in the anterior portion and a new peristome in the posterior part The anterior portion then curved round to the side of the rest of the body, and was finally constricted off from it

Habitat —Pond water and infusion of dry leaves. PUNJAB, Lahore Soils from N W F PROVINCE, Peshawar, PUNJAB, Ghora Gali, BOMBAY, UNITED PROVINCES, Agra, CENTRAL INDIA, Indore, BENGAL, Sibpore, ASSAM

262 **Pleurotricha lanceolata** (Ehrenberg) Stein (Fig 177)

Kerona calvitium, Muller, 1786, p 245, pl xxxiv, figs 11–13
Stylonichia lanceolata, Ehrenberg, 1838, p 373, pl xlii, fig 5
Pleurotricha lanceolata, Stein, 1859 *a*, p 4, 1859 *d*, pp 170–1, pl x, figs 2–4, Kent, 1880–2, p 783, pl xliii, figs 26, 27, Lepsi, 1926 *a*, p 85, fig 453, Schoenichen, 1927, p 233
†*Pleurotricha lanceolata* (?), Sandon, 1927, p 196, fig 12
Pleurotricha lanceolata, Manwell, 1928 *a*, pp 417–37, pls i–xii, figs 1–54, 1928 *b*, pp 433–6
†*Pleurotricha lanceolata*, Chaudhuri, 1929, p 54
Pleurotricha lanceolata, Kahl, 1930–5, p 593 fig 113, *4*

Body elongate-lanceolate, two and a half times as long as broad, pointed posteriorly, the anterior end curved slightly

Fig 177

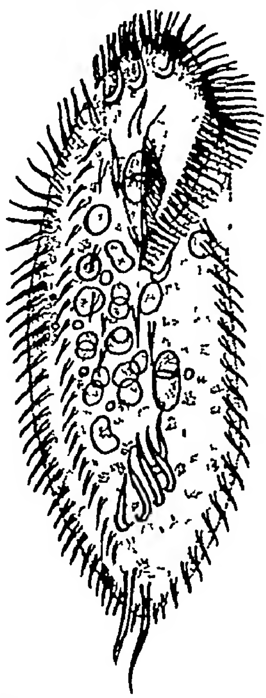


Fig 178

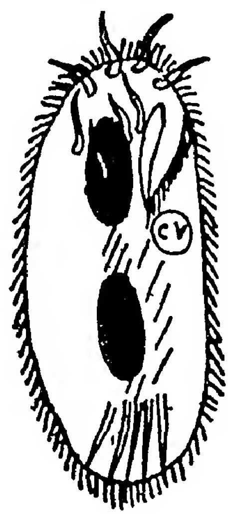


Fig 177 —*Pleurotricha lanceolata* (Ehrenberg) (After Sandon)
Fig 178 —*Gastrostyla setifera* (Engelmann) c v contractile vacuole (After Gulati)

towards the left Peristome, frontal, ventral, anal styles, and other details as in *P grandis*, one complete and a second incomplete row of supplementary ventral setæ on the right only of the larger ventral uncini Cyst characteristic, being covered with short, stout, straight spiny processes

Dimensions —Length 83–143 μ (Stein), 173–297 μ (Kent), 70–80 μ (Sandon), 100–165 μ (Manwell)

Fresh water, among aquatic plants, fairly common in soil

Remarks—Conjugation, division, and encystment in this species have been fully described by Manwell (1928 *a*)

Habitat—In soils KASHMIR, Srinagar, N W F PROVINCE, Peshawar, PUNJAB, Ghora Gali, Jullundur (?), DELHI, CENTRAL INDIA, Indore, HYDERABAD, MADRAS, Madras, ASSAM, Cinnamara

Genus **GASTROSTYLA** Engelmann, 1862

Gastrostyla, Engelmann, 1862, p 383, Kent, 1880–2, p 783, Butschli, 1887–9, p 1747, Roux, 1901, p 100, Lepsi, 1926 *a*, p 82, Schoenichen, 1927, p 233, Sandon, 1927, p 194, Kahl, 1930–5, p 593, Calkins, 1933, p 519

Body elliptical, anteriorly narrower, posteriorly rounded, flexible, but little contractile Peristome occupying about one-third of the body-length Eight frontal cirri Ventral cirri in one or two oblique rows, sometimes with a few additional scattered ones Four or five anal cirri, situated as in *Pleurotricha*, besides the marginal cilia, which form an uninterrupted row at the posterior extremity of the body No caudal bristles Single contractile vacuole, situated to the left in the middle part of the body Macronucleus in two or four ovoid masses Locomotion swift

263 **Gastrostyla setifera** (Engelmann) (Fig 178)

Pleurotricha setifera, Engelmann, 1862, p 39, pl xxx, fig 10
Gastrostyla setifera, Kent, 1880–2, p 784, Butschli, 1887–9, p 1248, fig 7
?*Gastrostyla setifera*, Gulati, 1925, p 752, fig 24
Gastrostyla setifera, Schoenichen, 1927, p 234
Gastrostyla (*Pleurotricha*) *setifera*, Kahl, 1930–5, p 595, fig 113, 6

Body elongate-lanceolate, constant in form, widest centrally, equally narrowed at the two extremities, about two and a half times as long as broad Peristome extending backwards, its reflected border bearing a band-like undulating membrane Frontal styles in the form of five uncini, the three anterior of which are largest, and three or more bristles situated further back, an oblique row of ventral styles as well as a few scattered ones, anal styles five in number, forming two groups of three and two each, only the latter projecting beyond the posterior border, marginal setæ coarse, forming an uninterrupted row, no caudal styles Contractile vacuole near the middle of the left lateral border Macronucleus consisting of two ovate masses

Dimensions—Length about 270 μ (Schoenichen), 312 μ (Kent)

Remarks—Engelmann, who originally described this species under the name of *Pleurotricha setifera*, mentions five frontal setæ and four or five additional frontal setæ which are interpreted by Kent as the anterior setæ of the oblique ventral row Schoenichen gives five uncini and four to six bristle-shaped frontal cirri Kent relegated the species to the genus *Gastrostyla*, as the latter is distinguished from *Pleurotricha* by the possession of a single oblique row of ventral setæ

The form described and figured by Gulati differs from the species, as defined above, in possessing eight frontal styles disposed in a typical arrangement, two short rows of ventral setæ, the five anal styles not being arranged in two groups, and in the very much smaller size, 90 μ by 30 μ only Either it was not correctly observed or it represents a distinct species

Habitat—Pond water PUNJAB, Lahore

Genus OXYTRICHA (Ehrenberg, 1830) Sterki, 1878

Oxytricha, Ehrenberg, 1830, p 43, 1838, p 363
Oxytricha, part, Dujardin, 1841, p 416
Oxytricha, Claparède & Lachmann, 1858–61, p 138, Stein, 1859 *d*, p 182, Engelmann, 1862, p 387, Fromentel, 1874, p 160, Sterki, 1878, pp 56–7, Kent, 1880–2, p 786, Bütschli, 1887–9, p 1749, Roux, 1901, p 100, Lepsi, 1926*a*, p 82, Schoenichen, 1927, p 234, Sandon, 1927, p 195, Reichenow, 1929, p 1207, Kahl, 1930–5, p 599, Calkins, 1933, p 521

Body elongate-oval, rounded at both ends, flexible and contractile Dorsal surface convex, least so in the middle part of the body, ventral surface flat Peristome large, sometimes extending to the neighbourhood of the middle of the body, right peristomial margin anteriorly bent to the left Adoral zone of cirri well developed anteriorly and along the left margin, more or less strongly curved Eight frontal cirri, five ventral cirri, two below the peristome, one in the middle, two above the anal cirri, sometimes with supplementary ones, and five well developed anal cirri Marginal row of setæ unbroken at the posterior end Often with dorsal bristles Contractile vacuole single Macronucleus double Locomotion swift, with frequent changes of direction

Kahl (1930–5) has divided the genus into seven subgenera, of which *Tachysoma* and *Stylonichia* are represented in India

264 **Oxytricha pellionella** (O F Muller) Ehrenberg (Fig 179)

Trichoda pellionella, O F Muller, 1773, p 80, 1786, p 222, pl xxxi, fig 21
Oxytricha pellionella, Ehrenberg, 1838, p 364, pl xl, fig 10, Dujardin, 1841, p 417, pl xi, fig 10, Stein, 1859 *d*, pp 185–6, pl xi, figs 13–18, Kent, 1880–2, p 786 pl xlv, figs 3–5
Tachysoma agilis, Stokes, 1887 *b*, p 180, pl iii, fig 6
Oxytricha pellionella, Butschli, 1887–9, pl lxxi, fig 9, Roux, 1901, p 101, pl vi, fig 5, Lepsi, 1926 *a*, p 86, fig 461, Schoenichen, 1927, p 236, fig 751, & pl xiii, fig 14
†*Oxytricha pellionella* (?), Sandon, 1927, p 196, pl vi, fig 14
†*Oxytricha pellionella*, Chaudhuri, 1929, p 54
Tachysoma (*Oxytricha*) *pellionella*, Kahl, 1930–5, p 606, fig 113, *31*

Body elongate-oval, moderately elastic, rather more than four times as long as broad, widest in the middle, lateral margins nearly parallel, uniformly rounded at both extremities Peristome rather narrow, about one-third the length of the body, not reaching the median line of the body in its maximum

Fig 179 —*Oxytricha pellionella* (O F Müller) (After Sandon)

width, with well developed adoral zone of membranelles, and a narrow undulating membrane along its right border Frontal cirri eight, ventral setæ five, anal uncini projecting to a considerable distance beyond the posterior end of the body, marginal setæ stationed at some distance from the periphery, row interrupted posteriorly Dorsal bristles well developed Contractile vacuole near the left border about the middle Macronucleus consisting of two oval masses, with adjacent micronuclei

Dimensions —Length 80–100 μ, width 19–24 μ

In stagnant water and in soil

Habitat —Sandon doubtfully records it from soils from PUNJAB, Jullundur, Chaudhuri from soils from PUNJAB, Lahore. CENTRAL INDIA, Indore

265 **Oxytricha** sp

Oxytricha sp , Carter, 1856

Habitat —Fresh water Bombay

266 **Oxytricha** sp

Oxytricha sp (?), Sandon, 1927, p 23

Habitat —Sandon doubtfully records it from wet paddy soil from MADRAS, Coimbatore

267 **Oxytricha** sp

Oxytricha sp , Chaudhuri, 1929, p 54

Chaudhuri mentions *Oxytricha* sp as a new record, but the locality is not indicated in his Table III

Genus **STYLONYCHIA** (Ehrenberg, 1830) emend Stein, 1859

Stylonychia, Ehrenberg, 1830, p 120 , 1838, p 370 , Claparède & Lachmann, 1858–61, p 154 , Stein, 1859 *d*, p 146 , Fromentel, 1874, p 162 , Kent, 1880–2, p 790 , Bütschli, 1887–9, p 1749 , Roux, 1901, p 103 , Lepsi, 1926 *a*, p 82 , Wenyon, 1926, p 1221 , Schoenichen, 1927, p 236 , Sandon, 1927, p 197 , Reichenow, 1929, p 1207 , Kahl, 1930–5, p 617

Free-swimming, medium-sized to very large, elongate-oval, persistent in shape , dorsal surface convex, ventral flat Peristome half as wide as the body, extending up to the middle, with its right border curved in a S-like manner, not or only slightly bent at its anterior end towards the left Eight frontal cirri typically situated , five claw-like ventral styles or uncini arranged in two rows , and five straight anal styles, as in *Oxytricha* The marginal setæ form on each side an even and continuous border, but are in most species separated at the posterior extremity by a gap in which are situated three very long bristle-shaped caudal styles, diverging at the end Macronucleus double, oval or elongate Contractile vacuole single, spherical, situated near the posterior angle of the peristome Locomotion quick, swimming and creeping, but not shooting backwards Inhabiting salt, fresh and stagnant water

Kahl (1930–5) regards *Stylonychia* as a subgenus of *Oxytricha* Ehrbg

268 Stylonychia pustulata Ehrenberg. (Fig 180)

Kerona pustulata (?), Müller, 1786, p 246, pl xxxiv, figs 14, 15
Kerona silurus (?), Muller, 1786, p 244, pl xxxiv, figs 9, 10
Kerona pustulata, Ehrenberg, 1830, pp 53, 63, 1831, p 119
Stylonychia pustulata, Ehrenberg, 1835, p 164, 1838, p 371, pl xlii, fig 1
Kerona pustulata, Dujardin, 1841, p 423, pl vi, fig 10, pl xiii, fig 7
Stylonychia pustulata, Claparède & Lachmann, 1858–61, p 161, pl vi, fig 2, Stein, 1859 *d*, pp 161–6, pl ix, figs 1–16, Fromentel, 1874, p 274, pl xiv, fig 9, Kent, 1880–2, p 791, pl xlv, figs 15–17
†*Stylonychia pustulata*, Daday, 1898, p 8
Stylonychia pustulata, Roux, 1901, p 104, pl vi, fig 9
†*Stylonychia pustulata*, Bhatia, 1922, p 33
Stylonychia pustulata, Lepsi, 1926 *a*, p 86, fig 467, Schoenichen, 1927, p 237, fig 753
†*Stylonychia pustulata*, Bhatia & Mullick, 1930, pp 401–2
Stylonychia pustulata, Kahl, 1930–5, p 619, fig 121, *21*, *21 a*

Body elongate-oval, equally wide in front of and behind the median line, the posterior extremity evenly rounded Frontal cirri eight, ventral cirri five, not arranged in a row, anal styles five, three or four of which project beyond the

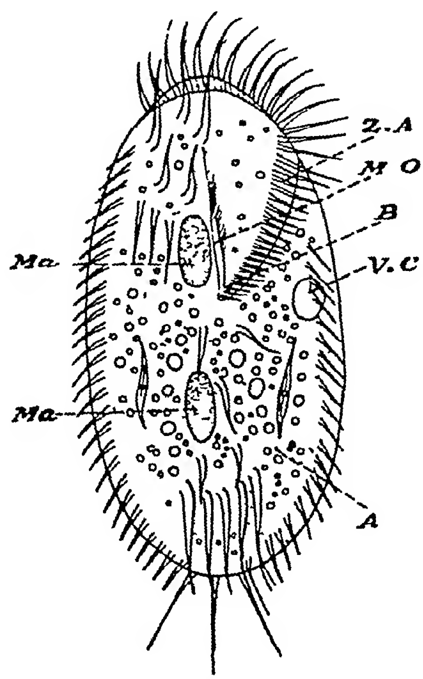


Fig 180 —*Stylonychia pustulata* Ehrenberg *A*, anus, *B*, cytostome, *Ma*, macronucleus, *M O*, undulating membrane, *V C*, contractile vacuole, *Z A*, adoral zone (After Roux)

posterior border, three long, diverging caudal styles, interrupting the marginal setæ at the posterior end of the body Peristome not quite half the length of the body, with a very narrow, indistinct undulating membrane Contractile vacuole close to the middle of the body Macronucleus consisting of two oval parts, with a micronucleus lying close to each Cysts spherical with warty projections

Dimensions —Length 150–220 μ

Occurs in salt, fresh and stagnant water, infusions, and soil Tolerant of carbon dioxide

Remarks —In the specimens found at Lahore the frontal cirri were eight in number and arranged in the characteristic manner, ventral setæ were present but not distinct, and their number could not be ascertained, anal styles were five in number, turned back, and projected beyond the posterior end of the body The marginal cilia were set within the border, and the row was interrupted at the posterior end by the three caudal styles characteristic of the genus, but these were not very long The macronucleus was central, consisting of two parts, oval in outline, and one part was partly overlying the other, no connecting thread being present

The Srinagar specimens resembled closely those from Lahore except that they measured 50–60 μ only The macronuclear portions lay at some distance from one another and the caudal styles were situated close to one another

Habitat —Pond water KASHMIR, Srinagar, PUNJAB, Lahore, and CEYLON, Kandy

269 **Stylonychia** sp

†*Stylonychia* sp, Chaudhuri, 1929, p 54

Habitat —Soil from UNITED PROVINCES, Agra

3 Subfamily PSILOTRICHINÆ Butschli, 1889

Frontal and ventral cirri much reduced, ventral cilia, apart from cirri, entirely absent Anal cirri often present

Genus **BALLADINOPSIS** Ghosh, 1921

Balladinopsis, Ghosh, 1921 *b* p 248
Balladynopsis, Kahl, 1930–5, p 592

Body rigid, elliptical, somewhat narrower anteriorly, rounded and wide posteriorly Dorsal surface convex,

ventral slightly convex Peristome narrow and extending to two-thirds of the length of the body Ventral cirri three in number and placed near the right peristomial margin in the anterior half of the body, anal cirri five, long, protruding beyond the posterior margin of the body Contractile vacuole single, median, near the right margin Macronuclei two, oval

The genus is represented by a single species, and resembles *Balladyna kowalewskii* in having a rigid body and elongated marginal cirri, in the absence of frontal cirri, in the number and arrangement of anal cirri, in the somewhat elongated membranelles, in the number of macro- and micronuclei, and in having a single contractile vacuole It differs, however, from that genus in the absence of a single uniform row of ventral cirri and the bristles on the dorsal surface

Kahl (1930–5) considers it to be very likely a degenerate form

270 **Balladinopsis nuda** Ghosh (Fig 181)

†*Balladinopsis nuda*, Ghosh, 1921 *b*, p 248, fig 1
Balladynopsis nuda, Kahl, 1930–5, p 592, fig 86, *21*

Body exhibits the characters given above under the genus. Peristome narrow, extending along the entire anterior margin

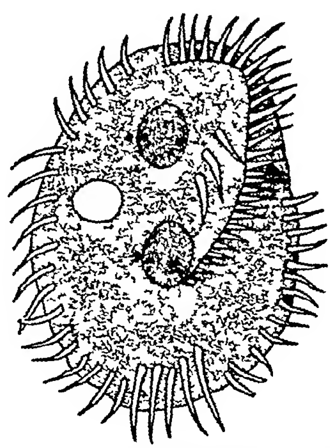


Fig 181 —*Balladinopsis nuda* Ghosh (After Ghosh)

and the anterior third of the left side, whence it curves inwards to nearly the median line, reaching the junction of the anterior two-thirds and posterior one-third of the body-length, membranelles long and narrow Anal cirri long, five in number, three on the left side in an oblique and two on the right side

in a transverse row, all projecting beyond the posterior margin of the body Marginal cirri long, arising from the ventral surface just inside the margin, on the right side extending along the entire margin, on the left from the middle and stopping short of the posterior end Contractile vacuole placed near the right lateral margin in the middle of the body Macronucleus consisting of two oval parts, each with a micro nucleus, one placed anteriorly and the other just behind the middle of the body

Dimensions —Length 63 μ, breadth 20 μ

Habitat —In vegetable infusions BENGAL, Calcutta

3. Family EUPLOTIDÆ Ehrenberg, 1838.

Body constant in form Cilia entirely replaced by cirri Frontal, ventral, and anal cirri present The anal cirri are characteristically five in number and specially strong, forming springing organs along with the ventrals and caudals A few marginal cirri present on the sides of the body or at the posterior end Dorsal bristles present Peristome harp-shaped or sickle-shaped Adoral zone of membranelles well developed on the anterior and left borders of the peristome Contractile vacuole posterior, to the right of the anus Macronucleus band-shaped, curved

Genus **EUPLOTES** (Ehrenberg, 1831) emend Stein, 1859

Euplotes, Ehrenberg, 1831, p 118, 1838, p 377
Ploesconia, Dujardin, 1841, p 431
Euplotes, Claparède & Lachmann, 1858–61, p 168, Stein, 1859 *d*, p 133, Fromentel, 1874, p 164, Kent, 1880–2, p 797, Bütschli, 1887–9, p 1752, Roux, 1901, p 108, Lepsi, 1926 *a*, p 80, Wenyon, 1926, p 1221, Schoenichen, 1927, p 240, Sandon, 1927, p 198, Reichenow, 1929, p 1207, Kudo, 1931, pp 389–90, Kahl, 1930–5, p 628, Calkin, 1933, p 521

Free-swimming Body constant in form, shield-shaped, colourless and transparent, or greenish through the presence of zoochlorellæ Dorsal surface more or less convex, sometimes smooth, but generally with sharp longitudinal ribs Ventral surface flattened, provided in its middle part with more or less elongated furrows running longitudinally Peristome harp-shaped or sickle-shaped, well developed, adoral zone of membranelles well developed on the anterior and left borders of the peristome Fronto-ventral cirri well developed and

variable in number, usually nine or ten Five strongly developed anal styles arranged in a transverse row Four flexible marginal cirri, situated along the posterior border Contractile vacuole single, spherical Macronucleus band-shaped, curved Locomotion swift, with frequent changes of surface And direction Feeding on Algæ, detritus and Flagellates, etc

Key to Indian Species.

1 (2)	Ten fronto ventral cirri, postero marginal setæ unbranched Length 80 μ	[Ehrbg, p 385 *E charon* (O F Müll)
2 (1)	Nine fronto-ventral cirri, two postero-marginal setæ branched or fimbriated Length 100–125 μ	[p 386. *E patella* Ehrbg,

271 **Euplotes charon** (O F Muller) Ehrenberg (Fig 182)

Trichoda charon, O F Müller, 1773, p 83, 1786, p 229, pl xxxii, figs 12–20
Trichoda cimex, O F Müller, 1773, p 84, 1786, p 231, pl xxxii, figs 21–24
Euplotes charon, Ehrenberg, 1838, p 378, pl xlii, fig x
Euplotes appendiculatus, Ehrenberg, 1838, p 379, pl xlii, fig xii
Plœsconia charon, Dujardin, 1841, p 439, pl x, figs 8, 13
Plœsconia affinis, Dujardin, 1841, p 441, pl vi, fig 7
Plœsconia subrotunda, Dujardin, 1841, p 441, pl xiii, fig 5
Plœsconia radiosa, Dujardin, 1841, p 442
Plœsconia longiremis, Dujardin, 1841, p 442, pl x, figs 9, 12
†*Himantophorus charon*, Carter, 1856 *b*, p 132, pl vii, fig 86
Euplotes charon, Claparède & Lachmann, 1858–61, p 173, pl vii, fig 10, Stein, 1859 *d*, pp 137–40, pl iv, figs 14–20, Fromentel, 1874, p 278, pl xii, fig 9, Kent, 1880–2, pp 799–800, pl xliv, figs 26–9, Bütschli, 1887–9, pl lxxii, fig 29, Roux, 1901, p 109, pl vi, fig 15, Bullington, 1925, p 272, Lepsi, 1926 *a*, p 83, fig 396, Schoenichen, 1927, p 240, fig 756, Sandon, 1927, p 198, pl vi, fig 10, Reichenow, 1929, p 1207, Kudo, 1931, p 390, fig 167 *a*, Kahl, 1930–5, p 633, fig 123, *13–15*, Calkins, 1933, p 160, fig 89 D

Medium-sized Shape regular, oval, rounded at the two extremities, slightly narrower in front than behind Peristome rather narrow Dorsal furrows not very distinct. Ten fronto-ventral cirri on the anterior half of the ventral surface Posterior marginal setæ small, not branched Contractile vacuole posterior Macronucleus band-shaped, curved.

Dimensions —Length 80 μ, breadth 38–40 μ

Salt and fresh water Very tolerant of deficiency of oxygen

Habitat —Fresh water BOMBAY

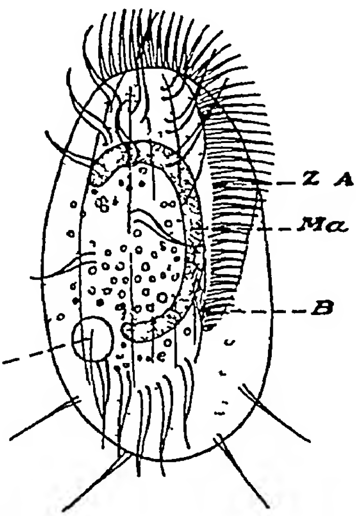


Fig 182 —*Euplotes charon* (O F Muller) *B*, cytostome, *Ma*, macronucleus, *V C*, contractile vacuole, *Z A*, adoral zone (After Roux)

272 **Euplotes patella** (O F Muller) Ehrenberg (Fig 183)

Kerona patella (?), Müller, 1786 p 238, pl xxxiii, figs 14–17
Euplotes patella, Ehrenberg, 1838, p 378, pl xlii, fig ix
Euplotes viridis, Ehrenberg, 1840, p 200
Plœsconia patella, Dujardin, 1841, p 435, pl viii, figs 1–4
Euplotes patella, Stein, 1859 *d*, pp 135–6, pl iv, figs 6–11, Claparède & Lachmann, 1858–61, p 170, pl vii, figs 1, 2, Kent, 1880–2, p 798, pl xliv, figs 23–5
Euplotes paradoxa, Kent, 1880–2, p 798
Euplotes patella, Butschli, 1887–9, pl lxxii, fig 2, Roux, 1901, p 109, pl vii, fig 1, Taylor, 1920, pp 403–70, pls xxix–xxxiii, Bullington, 1925, pp 249, 272, Lepsi, 1926 *a*, pp 82–3, fig 398, Wenyon, 1926, p 1221, fig 527, A, B, Schoenichen, 1927, p 240, pl xiii, fig 18, Sandon, 1927, p 199
†*Euplotes patella*, Madhava Rao, 1928, p 114, pl ii, fig 2
Euplotes patella, Kudo, 1931, p 390, fig 167 *b*
Euplotes (*Trichoda*) *patella*, Kahl, 1930–5, p 639, fig 124, *1*, *2*
Euplotes patella, Calkins, 1933, pp 94, 129–30, 182, figs 48, 72, 96

Medium-sized to large Roughly oval, truncated in front and rounded posteriorly, breadth nearly equal at the two extremities Peristome well developed, wide anteriorly Ventral surface with longitudinal ridges in the neighbourhood of anal cirri Fronto-ventral cirri nine, anal five, marginal four, the two on the right being branched or fimbriated Contractile vacuole posterior Macronucleus band-shaped, curved

Dimensions —Length 100–125 μ, breadth 60–75 μ

Food largely Diatoms and other Algæ Salt and fresh water.

Habitat —Soil MYSORE

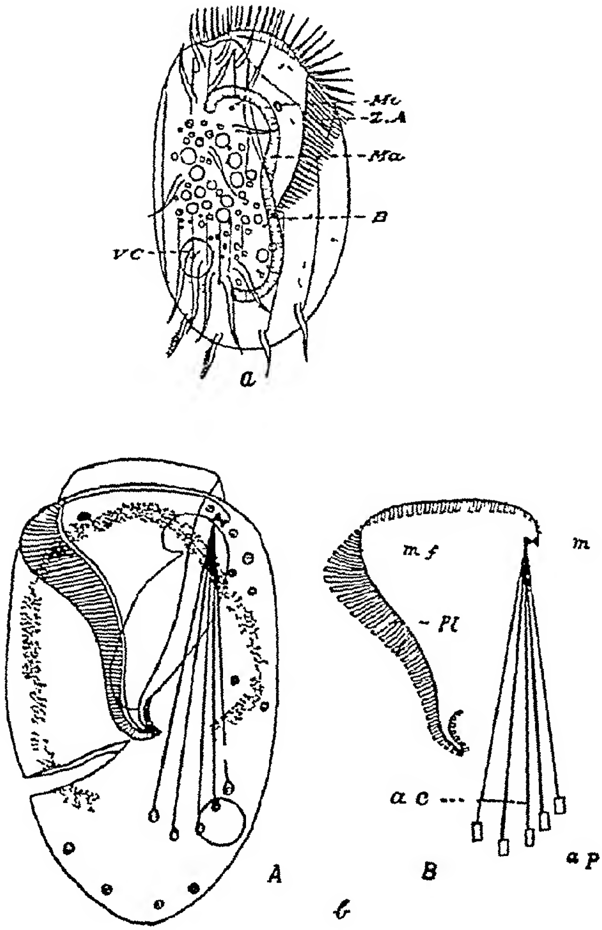


Fig 183—*a* *Euplotes patella* (O F Müller) *B*, cytostome, *Ma*, macronucleus, *Mi*, micronucleus, *V C*,, contractile vacuole, *Z A*, adoral zone (After Roux)
b Micro dissection of *Euplotes patella* A Individual with lateral cut, showing distribution of the various structures B Neuromotor apparatus isolated *a c*, fibres to anal cirri, *a.P*, basal plates of anal cirri, *m*, motorium, *m f*, membranelle fibre, *Pl*, membranelle plates (After Taylor)

4. Family ASPIDISCIDÆ Ehrenberg, 1838

Cilia are entirely replaced by cirri Frontal, ventral, and anal cirri present Marginal cirri completely absent Peristome very small, shifted to the left margin of the body, it lies covered by a transparent fold extending from the right margin of the body Adoral zone of membranelles confined to the left and not marking off a frontal field Dorsal bristles absent Contractile vacuole posterior Macronucleus band-shaped, curved

Key to Indian Genera

1 (2)	Peristome begins at the anterior end, 7 fronto-ventral and 5 anal cirri	[p 388 ASPIDISCA Ehrnbg,
2 (1)	Peristome begins at the left lateral margin, 4 frontal well differentiated from 5 ventral, and 5 anal cirri	[p 391 ASPIDISCOPSIS Ghosh,

Genus ASPIDISCA Ehrenberg, 1830

Aspidisca, Ehrenberg, 1830, p 42, 1838, p 344, Dujardin, 1841, p 448, Claparède & Lachmann, 1858–61, p 188, Stein, 1859 *d*, p 121, Fromentel, 1874, p 164, Kent, 1880–2, p 792, Butschli, 1887–9, p 1754, Roux, 1901, p 110, Lepsi, 1926 *a*, p 80, Schoenichen, 1927, p 241, Reichenow, 1929, p 1207, Kudo, 1931, p 390, Kahl 1930–5, p 343, Calkins, 1933, p 521

Free-swimming Very small or small, encuirassed, orbicular or shield-shaped Dorsal surface more or less convex Ventral surface plane, with its right border thickened Peristome set far back on the left side, with a simple arcuate fringe of adoral cirri, the right border of the peristome spread out into a plate covering the furrow more or less completely, and sometimes projecting beyond the left margin of the body. Cirri strong and long, seven fronto-ventral cirri (in two species nine to fifteen anterior fronto-ventral cirri), and from five to twelve transverse or anal styles Anal aperture placed far back, a little in advance of the posterior or anal styles. Contractile vacuole single, posterior Macronucleus curved in a horseshoe-shaped manner Locomotion irregular Salt or fresh water

Key to Indian Species

1	Transverse cirri at some distance from the posterior end, 3 right transverse cirri situated in an anterior group apart from the others	2
2 (3)	Dorsal surface smooth or with 3 feeble longitudinal furrows	[p 390. *A lynceus* (O F Mull),
3 (2)	Dorsal surface with 5 or 6 well marked longitudinal furrows	[Stein, p 389. *A costata* (Duj)

273 Aspidisca costata (Dujardin) Stein (Fig. 184)

Loxodes plicatus (?), Ehrenberg, 1838, p 325, pl xxxiv, fig 4
Coccudina costata, Dujardin, 1841, p 446, pl x, fig 1
Aspidisca cicada, Claparède & Lachmann, 1858–61, p 190, pl vii, figs 13–15
Aspidisca costata, Stein, 1859 *d*, p 125, pl iii, figs 15–17, Kent, 1880–2, pp 794–5, pl xlv, figs 25–29, Roux, 1901, p 111, pl vii, fig 3
†*Aspidisca costata*, Bhatia, 1920, p 262
Aspidisca costata, Bullington, 1925, p 272, Lepsi, 1926 *a*, p 83, fig 412, Schoenichen, 1927, p 242, fig 759
Aspidisca (*Coccudina*) *costata*, Kahl, 1930–5, p 645, fig 125, 3

Body nearly ovate, rounded at both extremities, wider in the posterior part of the body The right border of the peristome forms a wide plate, which extends beyond the left

Fig 184

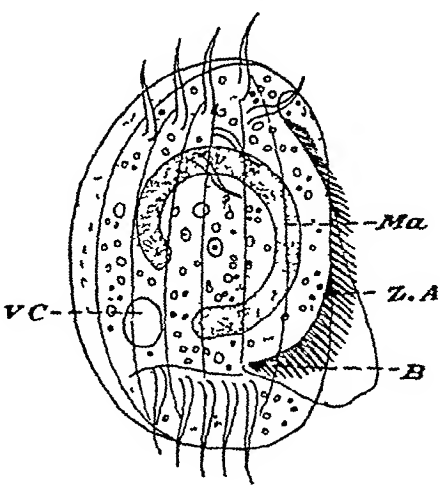


Fig 185

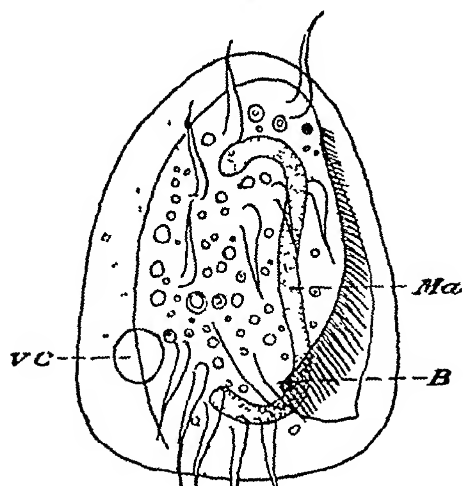


Fig 184 —*Aspidisca costata* (Dujardin) *B*, cytostome, *Ma*, macronucleus, *V C* contractile vacuole, *Z A*, adoral zone (After Roux)
Fig 185 —*Aspidisca lynceus* (O F Muller) Lettering as in the previous figure (After Roux)

border of the body and is rounded posteriorly, terminating near the anal cirri Dorsal surface convex, traversed by five or six well-marked longitudinal furrows Fronto-ventral styles seven in number, forming two anterior, oblique, parallel rows of three each, the seventh style stationed by itself to the right and rear of the other six, anal styles five

Dimensions —Length 30–40 μ, width 22–31 μ

Remarks —The form exhibited six deep furrows on the dorsal surface, along which were also seen distinct rows of large

bristles Specimens belonging to this species were also found in a sample of pond water sent from Lucknow by Dr G S Thapar

Habitat —Pond water PUNJAB, Lahore , UNITED PROVINCES, Lucknow

274 **Aspidisca lynceus** (O F Muller) (Fig 185)

> *Trichoda lynceus*, O F Muller, 1773, p 86, 1786, p 225, pl xxxii, figs 1, 2
> *Aspidisca lynceus*, Ehrenberg, 1838, p 344, pl xxxix, fig 1
> *Coccudina crassa*, Dujardin, 1841, p 446, pl x, fig 2
> *Aspidisca lynceus*, Claparède & Lachmann, 1858–61, p 191, pl vii, fig 16 , Stein, 1859 *d*, pp 123–4, pl iii, figs 4–10 , Kent, 1880–2, p 793 , Butschli, 1887–9, pl lxxii, fig 5 *c* , Roux, 1901, p 110, pl vii, fig 2
> †*Aspidisca lynceus*, Bhatia, 1920, p 263
> *Aspidisca lynceus*, Lepsi, 1926 *a*, p 83, fig 411 , Schoenichen, 1927, p 242, pl xiii, fig 19 , Reichenow, 1929, p 1207, fig 1188, D , Kudo, 1931, p 391, fig 168 *a* , Kahl, 1930–5, p. 644, fig 125, *6*

Body ovate, widest and somewhat truncate posteriorly , the marginal border of the carapace entirely even, the left margin less strongly convex than the right The right border of the peristome does not extend beyond the left margin of the body, but is rather pointed posteriorly Dorsal surface smooth or marked longitudinally with three feeble furrows Ventral surface bearing seven fronto-ventral and five anal styles

Dimensions —Length 30–50 μ, maximum width 25–32 μ

Fresh water or salt water

Remarks —As observed at Lahore, the animal would swim round and round, now from left to right, now from right to left, sometimes stopping and jumping or creeping forward The body was rigid and constant in form, the anterior end narrower and with a cleft under its overlap The peristomial cleft was very small, arising from the left margin of the body, and with a very short zone of adoral cirri The dorsal surface was smooth, and not furrowed or provided with a backwardly pointing stalk Five distinct anal styles were present There were seven other styles situated on the ventral surface of the body, four on the central part and three near the anterior end projecting beyond the anterior extremity The contractile vacuole was situated on the right side a little in advance of the anal styles The nucleus was horseshoe-shaped The specimens were small and measured only 24 μ by 21 μ

Habitat —Fresh water PUNJAB, Lahore

Genus ASPIDISCOPSIS Ghosh, 1921.

Aspidiscopsis, Ghosh, 1921 *b*, p 249

Body broadly ovate, narrow and rounded anteriorly and broadly subtruncate behind Dorsal surface convex, with six or seven longitudinal ribs Right margin of the body evenly convex, left margin with a shallow notch just behind the anterior end Peristome obliquely crescentic, occupying the postero-lateral portion of ventral surface, with membranelles Frontal cirri four, ventral cirri five, anal cirri five Contractile vacuole posterior Macronucleus band-shaped, curved like a bow, and placed to the left of the median line Movements brisk

275 Aspidiscopsis bengalensis Ghosh (Fig 186)

†*Aspidiscopsis bengalensis*, Ghosh, 1921 *b*, pp 249–250, fig 2
Aspidisca (*Aspidiscopsis*) *bengalensis* Kahl, 1930–5, p 644, fig 125, 26

Body broadly ovate, narrow and tapering to a rounded end in front, broadly and obliquely subtruncate behind.

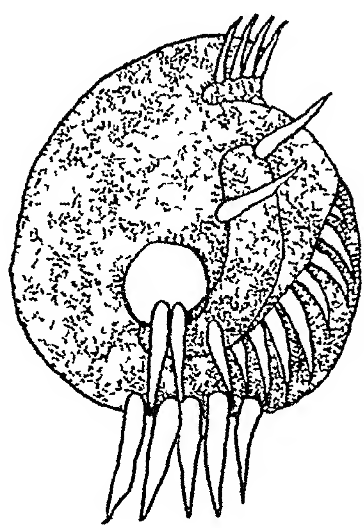


Fig 186 —*Aspidiscopsis bengalensis* Ghosh (After Ghosh)

Dorsal surface convex, with six or seven longitudinal ribs. Right margin evenly convex, left margin with a shallow notch just behind the anterior end, but uniformly convex behind the notch, notch produced into a groove on the ventral aspect. Peristome obliquely crescentic, occupying the postero-lateral

portion of the ventral surface, from the left margin to half way across the posterior portion of the body, provided with about eight membranelles Frontal cirri four, just in front of the notch Ventral cirri five, one behind the notch, another further behind and more median, the next two stout and lying side by side, and the fifth one behind and to the left of these Anal cirri five, four on the right are long, stout, and placed side by side, the fifth one somewhat separated, smallest, and on the left Contractile vacuole posterior Macronucleus band-like, curved like a bow, and placed obliquely to the left of the median line

Dimensions —Length 21 4 μ, breadth 16 μ

Habitat —Pond water BENGAL, Calcutta

III. Order PERITRICHA Stein.

The majority of the PERITRICHA are typically bell-shaped, attached forms with or without prolongations of the posterior (aboral) end in the form of a stalk. The stalk may or may not contain a myoneme thread, and is consequently either highly contractile or rigid. Generally there are no cilia on the body. The anterior (oral) end of the body forms the peristomial field and bears a projecting peristomial disc which carries the adoral zone of cilia. This consists of two parallel ciliary girdles which run round spirally to the left (contra-clockwise) and are continued down into the vestibule. The outer girdle consists of a single row of cilia fused to form the outer peristomial membrane which projects out radially over the peristomial border, forming a kind of circular shelf. The inner girdle consists of two rows of cilia, which are neither completely free nor completely fused to form membranes. They are fused proximally, but are frayed out into separate cilia at the tips. They are obliquely placed and produce by their movement a whirlpool, bringing particles of food, which is directed towards the vestibule by the outer membrane. Both the girdles run spirally to the bottom of the vestibule. Where the outer membrane descends into the vestibule its base parts company with the bases of the inner membranes and follows the outer wall of the vestibule in its descent into the interior of the cell. This descending portion of the outer membrane is composed of much stronger cilia, which are fused into a typical, definite undulating membrane. The peristomial groove runs between the margin of the bell or the peristomial border and the margin of the ciliary disc, and is continued down as a deep funnel-shaped vestibule, at the bottom of which is situated the cytostome, followed by a delicate, non-ciliated cytopharynx which remains collapsed except when a food-particle passes down it. A single contractile vacuole is situated to one side of the vestibule and communicates with a reservoir which opens into the vestibule. Anus is situated close to the cytostome and also opens into the vestibule (fig. 187). Macronucleus is usually horseshoe-shaped or band-shaped. Micronucleus is minute, situated close to the macronucleus.

Binary fission is apparently longitudinal, but this is due to the special modification of the body, the morphological dorsal and ventral surfaces being represented by the oral and aboral

ends Conjugation is anisogamous, dimorphic conjugants are formed, and the fusion is complete and permanent

The majority of the PERITRICHA are sedentary throughout the greater part of their existence In the primitive forms (*Scyphidia*) the attachment is made by the aboral end, which acts like a sucker In other cases the body is provided with a

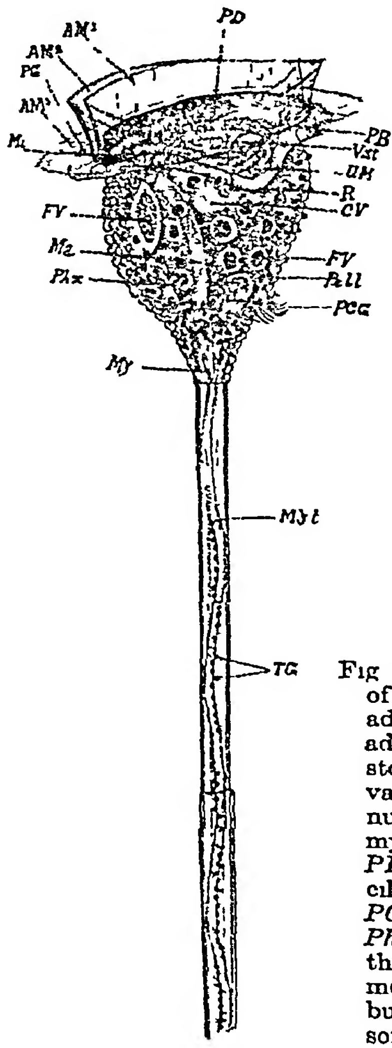


Fig 187 —Diagram showing the structure of a typical Vorticellid *AM*[1], inner adoral row of cilia, *AM*[2], middle adoral row of cilia, *AM*[3], outer peristomial membrane, *CV*, contractile vacuole, *FV*, food-vacuole, *Ma*, macronucleus, *Mi*, micronucleus, *My*, myoneme, *My t*, myoneme thread, *PB*, peristomial border, *PCG*, posterior ciliary girdle, *PD*, peristomial disc, *PG*, peristomial groove, *Pcll*, pellicle, *Phx*, cytopharynx, *R*, reservoir, *TG*, thecoplasmic granules, *Um*, undulating membrane in the vestibule, *Vst*, vestibule (After Noland & Finley lettering somewhat altered)

stalk which is rigid (*Epistylis*) or spirally contractile (*Vorticella*, *Carchesium*) Many of these stalked forms form large branching colonies Even in the stalked forms the individual may, after developing a posterior girdle of cilia, detach itself from the stalk and swim away as a solitary individual, only to settle again somewhere and develop a new stalk Apart from this posterior girdle the body cilia are, as a rule, absent

in Vorticellidæ, but may be present in Urceolidæ Some genera (*Cothurnia*, *Vaginicola*) secrete a tube which is attached to some animal or plant, or a colony of stalked individuals may secrete a common gelatinous covering (*Ophrydium*)

Kahl (1933) has classified the order into two suborders, as follows —

1 (2)	Capable of moving from place to place, with a posterior ciliary girdle, usually ectocommensal on Metazoa	Suborder **Mobilia**, [p 395
2 (1)	Sessile in the fully developed condition	Suborder **Sessilia**, [p 395.

1. Suborder *MOBILIA* Kahl, 1933.

The suborder includes a single family, Urceolariidæ Stein, which is not known from India so far

2. Suborder *SESSILIA* Kahl, 1933.

The suborder is divided into two tribes —

1 (2)	Without test .	Tribe **Aloricata**, p 395.
2 (1)	With test	Tribe **Loricata**, p 418

1. Tribe ALORICATA Kahl, 1933.

Usually bell-shaped, with or without a stalk, which may be spirally contractile or rigid Ordinarily no cilia on the body Posterior cilia, when developed, temporary Oral end of the body shows the peristomial field and bears a projecting disc which carries the adoral zone of cilia The adoral zone consists of two or three parallel ciliary girdles running spirally to the left (contra-clockwise) and continued down into the vestibule. Peristome is surrounded by a raised, contractile peristomial border, which closes over the disc and the cilia when the organism retracts Peristomial groove is continued down as the vestibule, at the bottom of which is the cytostome, followed by a short cytopharynx Contractile vacuole and anus both open into the vestibule Macronucleus horseshoe-shaped or band-shaped Micronucleus single Binary fission apparently longitudinal Conjugation anisogamous

It is very interesting to watch a living Vorticellid It not only springs forwards and backwards by the expansion and contraction of the stalk, but has also the power of opening out or contracting its anterior end When fully expanded the peristomial border is everted, like the rim of a bell. the disc

is protruded, and the whorls of cilia are seen working beautifully In some species the disc is protruded far above the peristomial border, in others it scarcely reaches on a level with it When the organism contracts the disc is withdrawn, the cilia turned in, and it is covered over by the peristomial border folding in, the body thus assuming a pyriform shape

Identification Table of Families

1 (2)	Stalkless, with a cup like organ of attachment at the posterior end (generally attached on bodies of Metazoa)	[p 396 **Scyphidiidæ** Kahl,
2 (1)	With stalk in the adult state	3 [p 398
3 (4)	Stalk with a contractile thread	**Vorticellidæ** Stein,
4 (3)	Stalk without a contractile thread	**Epistylidæ** Kahl, p 413

1. Family SCYPHIDIIDÆ Kahl, 1933.

The family includes *Vorticella*-like organisms which do not possess a stalk even in the adult condition The organisms are attached to the body of various animals by a cup-like disc at the posterior end

Genus **SCYPHIDIA** (Dujardin, 1841) Lachmann, 1856

Scyphidia, Dujardin, 1841, p 538, Lachmann, 1856, p 348 Claparède & Lachmann, 1858–61, p 115, Fromentel, 1874, p 144, Kent, 1880–2, p 658, Butschli, 1887–9, p 1761, Roux, 1901, p 114 Lepsi, *1926a*, p 88, Schoenichen, *1927*, p *246*, Reichenow, 1929, p 1209, Calkins, 1933, p 522, Kahl, 1933, p 124, 1930–5, p 669

Animalcules solitary, medium to large sized, form variable, cylindrical or urn-shaped, highly contractile, adherent posteriorly to foreign bodies by means of a specially developed acetabuliform organ of attachment Surface of the integument often transversely or obliquely furrowed Body without cilia Oral end with a ciliary disc provided with two ciliary girdles, running in a contra-clockwise spiral Margin of the peristome padded, rarely turned down Peristomial groove continued as a vestibule, with the cytostome at its end Position of contractile vacuole variable Macronucleus of variable form

Key to Indian Species

1	Body elongate, transversely wrinkled Macronucleus spherical	[p 397 *S indica*, sp n,
2	Body cylindrical, slightly wider posteriorly, smooth Macronucleus a spiral band .	[Ghosh, p 398 *S purniensis*,

276 **Scyphidia indica**, sp nov (Fig 188)

†*Scyphidia fromentellii* (?), Bhatia, 1920, p 263

Body elongate, urn-shaped, anteriorly truncate, the posterior extremity contracted, stalk-like, not longitudinally plicate, remainder of the body transversely wrinkled Peristomial margin thickened and eversible Contractile vacuole single Macronucleus spherical

Dimensions —Length 52 μ

Fresh water, on *Daphnia*

Remarks —The specimens were found in Lahore, and were originally with some hesitation referred to *S fromentellii* Kent The body was small, measuring 52 μ by 25 μ, form elongated, posterior end thinner and provided with a rounded sucking-cup In a specimen detached from the host this posterior end was seen to contract independently, as in sucking The body surface was transversely wrinkled and the posterior extremity was not longitudinally plicate The peristomial margin was thickened and eversible The contractile vacuole

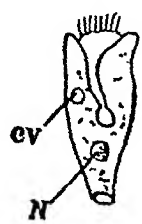


Fig 188 —*Scyphidia indica*, sp nov *C V*, contractile vacuole, *N*, nucleus

was single, placed anteriorly in front of the middle of the body Kent records having received "specimens of the Entomostracan *Daphnia pulex* extensively infested with a minute sessile Vorticellidan agreeing in all respects, except for the presence of a single and normally located contractile vesicle, with the species now under discussion as figured and described by De Fromentel" The form that came under my observation differs from the type of *S fromentellii*, as recorded by Kent, not only in possessing a single normally located contractile vacuole, but also in the body surface being transversely wrinkled and the posterior extremity of the body not being longitudinally plicate In its shape and in being transversely wrinkled it agrees with *S amœbea* Grenfell, but differs from it in the absence of an irregular shaped plate at the posterior extremity and in the form of the macronucleus I consider that it is a hitherto undescribed species.

Habitat —Pond water PUNJAB, Lahore

277 Scyphidia purniensis Ghosh

†*Scyphidia purniensis*, Ghosh, 1923, p 74

Body cylindrical, slightly wider posteriorly, spheroidal when contracted Surface smooth Peristomial margin thin and slightly everted, but not revolute, peristomial groove shallow, ciliary disc not elevate, vestibule prolonged backwards as a narrow straight canal beyond the middle of the body-length Contractile vacuole beneath the peristome at the side of the vestibule Macronucleus a spiral band of more than two turns

Remarks —Neither a drawing nor dimensions are given by the author of the species It is said to agree with *S patella* Cuénot in having the body surface smooth, but to differ from that species in its wider posterior end and from all known species in its spiral band-like macronucleus

Habitat —Pond water BENGAL, Purnea

2. Family VORTICELLIDÆ Stein, 1859

Body without test Posterior end of the body provided with a contractile stalk, which may be simple or branching

Key to Genera

1 (2)	Stalk not branching	VORTICELLA Linn, [emend Ehrbg, [p 398
2 (1)	Stalk branching	3
3 (4)	Contractile threads in the lateral branches not united with the thread in the main stalk	CARCHESIUM Ehrbg, [p 409
4 (3)	Contractile threads from the lateral branches continuous with the thread in the main stalk	ZOOTHAMNIUM * St

Genus VORTICELLA (Linnæus, 1767) emend Ehrenberg, 1838.

Vorticella, Linnæus, 1767, p 1317, O F Müller, 1773, p 96, Ehrenberg, 1838, p 269, Dujardin, 1841, p 546, Claparède & Lachmann, 1858–61, p 94, Stein, 1867, p 168, Greef, 1870, pp 353–84, 1871, pp 185–221, Fromentel, 1874, p 141, Kent, 1880–2, p 667, Butschli, 1887–9, p 1763, Roux, 1901, p 116, Penard, 1922, p 251, Lepsi, 1926*a*, p 87, Wenyon, 1926, p 1223, Schoenichen, 1927, p 248, Sandon, 1927, p 200, Reichenow, 1929, p 1210, Noland & Finley, 1931, pp 81–123, Kudo, 1931, p 394, Calkins, 1933, p 522, Kahl, 1933, p 125, 1930–5, p 712

Animalcules small or medium-sized, ovate, sphæroidal, pyriform or campanulate, attached posteriorly by a simple, undivided, more or less elongate and thread-like pedicle

which encloses an elastic, spirally disposed, contractile axial filament, on contraction the pedicle suddenly assumes a much shortened and usually corkscrew-like contour Adoral zone consists of two or three parallel ciliary girdles running spirally to the left (contra-clockwise), the right limb of which descends into the vestibule and the left limb is obliquely elevated and encircles the ciliary disc The entire adoral zone is contained within and bounded by a more or less distinctly raised annular peristomial border, between which and the elevated ciliary disc, on the ventral side, the widely excavated oral fossa or vestibule is situated, the vestibule is continued further into a cleft-like cytopharynx Anal aperture opening into the vestibular fossa Contractile vacuole single, spherical, usually opening into a reservoir, which in turn opens into the vestibule Macronucleus almost always elongated, band-shaped, with a micronucleus lying close to it

The animals possess, in all cases, separate spirally contractile stalks, with which they attach themselves to other objects Some species are, however, colonial, occurring in little "families," fixed and appearing as white little clouds amongst the roots of *Lemna*, the feathery leaves of *Ceratophyllum* and other plants, on the tentacles and legs of cyclopods, beetles, water-lice, crabs and other animals, as also on the walls of the vessels containing pond water Often the whole family suddenly contracts together, all zooids acting simultaneously, and then again extend themselves slowly and majestically Inhabiting salt and fresh water, many species only in clear water others only in water with decaying matter.

Key to Indian Species

1 (12)	Cuticular surface smooth	2
2 (5)	Body conical or elongate	3
3 (4)	Body elongate, cylindrical, about thrice as long as broad Length 15 μ (?) Pedicle as long as body	[p 407 *V subcylindrica* Ghosh
4 (3)	Body somewhat vase shaped, one and a half times as long as broad, rounded in the middle, with constrictions above and below the middle Body-length 15 μ (?) Pedicle twice as long as body	[p 409 *V subsinuata* Ghosh,
5 (2)	Body not conical or elongate	6
6 (11)	Body more or less campanulate	7
7 (10)	Body broadly campanulate	8
8 (9)	Peristomial margin broad, padded Sides of the body curved Body-length 50–157 μ Pedicle thick	[p 400 *V campanula* Ehrnbg,
9 (8)	Peristomial margin broad, not padded Sides of the body almost straight Body-length up to 120 μ Pedicle slender	[p 402 *V citrina* O F Müll,

10 (7) Body conical-campanulate, widest at the anterior border and tapering thence in a straight line to its point of junction with the pedicle. Peristomial border thin. Body-length up to 90 μ. Pedicle slender [p 406
V. *patellina* Ehrnbg,

11 (6) Body spheroidal, posterior end tapering abruptly to a point. Peristomial margin half the greatest diameter of the body. Body-length 25 μ. Pedicle four to five times the body-length [p 404
V. *globosa* Ghosh,

12 (1) Cuticular surface transversely striated 13

13 Body conical or elongate 14

14 Body somewhat vase shaped, broadest in the middle and narrowing anteriorly and posteriorly 15

15 (16) Peristome not everted, about half the maximum width of the body. Body-length up to 100 μ. Pedicle very slender [p 405
V. *microstoma* Ehrnbg,

16 (15) Peristomial margin widely everted and slightly less than the maximum width of the body. Body length 76 μ. Pedicle stout and less than twice the body-length [Ghosh, p 407
V. *submicrostoma*

17 Body conical campanulate, widest anteriorly 18

18 (19) Body scarcely twice as long as broad. Peristomial margin dilated, slightly revolute. Body length up to 120 μ. Pedicle thick, three to six times the body-length [p 403
V. *convallaria* Linn.,

19 (18) Body curved, one and a half times as long as broad. Peristomial margin placed obliquely and slightly everted. Body length 15 μ (?). Pedicle slender, four to five times the body-length [p 408
V. *subprocumbens* Ghosh

278 Vorticella campanula Ehrenberg (Fig 189)

Vorticella campanula Ehrenberg, 1831, p 92, 1835, p 165, 1838, p 273, pl xxv, fig iv

Vorticella lunaris Dujardin 1841, p 554, pl xiv fig 12

Vorticella campanula Claparede & Lachmann, 1858–61, p 97; Fromentel, 1874, p 232, pl v, fig 2, Kent, 1880–2, p 678, pl xxxiv, fig 36, pl xlix, fig 12, Roux, 1901, pp 116–17, pl vii, fig 10

†*Vorticella campanula* Bhatia, 1920, p 263

Vorticella campanula, Bullington, 1925, p 269, Lepsi 1926 *a*, p 91 fig 512, Schoenichen, 1927, p 250, fig 771, pl xiii, fig 266, Sandon, 1927, p 201, Noland & Finley, 1931, pp 105–6 figs 18–25, Kudo, 1931, p 394, fig 169 c, Kahl 1930–5 p 722, fig 125 *21, 21 a*

Body usually broadly campanulate or hemispherical, but soft and very variable in contour, when contracted subspheroidal with a puckered anterior margin. The frontal

margin widely dilated, often exceeding in width the length of the body, the ciliary wreath apparently forming two or more spiral convolutions Pedicle thick, varying from three or four to six or seven times the length of the body Cuticular surface smooth, highly elastic, parenchyma densely granular centrally. Macronucleus worm-like, bent

Dimensions—Body-length 50–157 μ

Pond water Social

Remarks—Found at Lahore in pond water on leaves of *Lemna* Social, a body-length of 63 μ to 73 μ being common Noland and Finley give 68 μ as the mode of the body-length and 50–157 μ as limits

The body was campanulate and slightly narrowed behind the anterior end, which was not much widened out, the length of the body was one and a quarter to one and a half times the

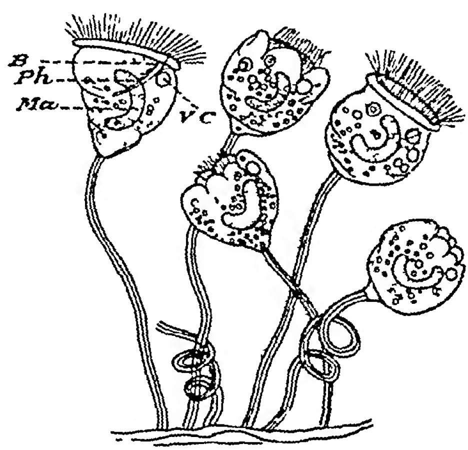


Fig 189.—*Vorticella campanula* Ehrbg *B*, cytostome, *Ma*, macronucleus; *Ph*, gullet, *V C*, contractile vacuole (After Roux)

maximum width The peristome was thickened and was slightly eversible, the ciliary disc projected slightly in a condition of expansion and bore fine long, close-set cilia The cuticular surface was smooth and the parenchyma densely granular The stalk was four to five times the length of the body, and the thread in the stalk was uninterrupted

Noland and Finley mention that the pellicular striæ are faint, requiring close focussing, and that small transparent spherules (about 1 μ), interpreted by Faure-Fremiet (1910) as mitochondria, are visible sometimes in the living animal in the thin peristomial border The thecoplasmic granules in the stalk are numerous

Habitat—Pond water PUNJAB, Lahore

279 Vorticella citrina O F Muller (Fig 190)

Vorticella citrina, O F Muller, 1773, p 123, 1786, p 306, pl xliv, figs 1–7, Ehrenberg, 1830, pp 41, 81, pl v, fig B, 1831, p 91, 1838, pp 271–2, pl xxv, fig iii, Claparède & Lachmann, 1858–61, p 96, Kent, 1880–2, pp 678–9, pl xxxv, fig 29 pl xlix, fig 13, Roux, 1901, p 117, pl vii, fig 11

†*Vorticella citrina*, Bhatia, 1920, p 264

Vorticella citrina, Bullington, 1925, p 269, Lepsi, 1926*a*, p 91, fig 513, Sandon, 1927, p 201, Schoenichen, 1927, p 250, fig 772, Noland & Finley, 1931, p 93, Kahl, 1933, p 128, 1930–5, p 717, fig 135, *23 a, b, c*

Body broadly campanulate, plastic and changeable in form, smooth Peristomial border broad, crateriform, often considerably exceeding in diameter the entire length of the body, not padded Sides of the body almost straight, posterior

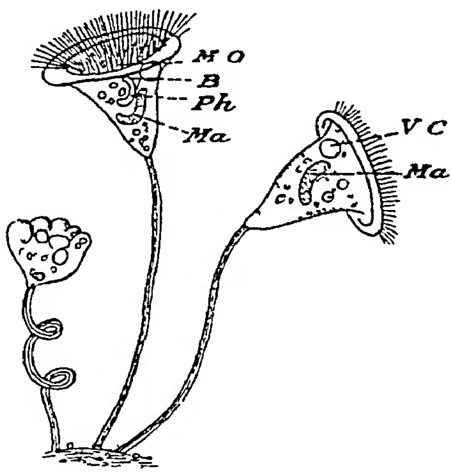


Fig 190 —*Vorticella citrina* O F Müll *B*, cytostome, *Ma*, macronucleus, *M O*, adoral zone, *Ph*, gullet, *V C*, contractile vacuole (After Roux)

end drawn out and pointed, depressed and with a puckered anterior border when contracted Parenchyma transparent, usually pale yellow Pedicle slender, four or five times the length of the body

Dimensions —Body-length up to 120 μ

Fresh water, on various aquatic plants Social

Remarks —Found very abundantly at Lahore in infusions of dry leaves and in pond water on various aquatic plants The body was broadly campanulate, not narrowed behind the anterior end The sides of the body were straight and the posterior end was drawn out into a cone-like process The length of the body, including the basal cone-like projection, was 26 μ in a contracted and 50 μ in an expanded specimen

The stalk was about three to five times the length of the body Spherical cysts of the zooids, measuring 24 μ across, were later found in abundance in the same culture

Noland and Finley (1931) remark as follows —" *V citrina* O F Muller, 1773, was distinguished largely on the basis of its greenish-yellow colour Fauré-Fremiet (1904) regards it as a physiological variant of *V convallaria* If it is distinct its identity must be based on other grounds than color alone "

I have, however, followed Roux, Lepsi, and Schoenichen in retaining it as a distinct species *V citrina* differs from *V convallaria* in the body being smooth and broadly companulate in the former and transversely striate and conical-campanulate in the latter, the sides of the body are straight in the former and curve inwards behind the anterior end in the latter, the peristomial border is not thickened in the former, and is padded in the latter These characters are sufficient to show the distinctness of the two species

Habitat —Fresh water, on various aquatic plants PUNJAB, Lahore

280 **Vorticella convallaria** Linnæus (Fig 191)

Vorticella convallaria, Linnæus, 1767, p 1319, Ehrenberg, 1830, pp 66, 79, pl v A, 1831, p 92, 1838, p 274, pl xxvi, fig iii, Dujardin, 1841, p 557, Claparède & Lachmann, 1858–61, p 95
†*Vorticella convallaria* (?), Carter, 1856*b*, p 247, pl vii, fig 77
Vorticella convallaria, Kent, 1880–2, pp 686–7, pl xlix, fig 34, Roux, 1901, p 119, pl vii, fig 19, Lepsi, 1926*a*, p 90, fig 531, Schoenichen, 1927, p. 249, pl xiii, fig 26 c, & fig 764, Noland & Finley, 1931, pp 94, 104–5, figs 10–17, Kahl, 1930–5, p 722, figs 136, *34*, 138, *44*

Body conical-campanulate, scarcely twice as long as broad, anteriorly as wide as in the middle Peristomial border dilated, slightly revolute Cuticular surface transversely annulate Parenchyma clear, transparent, sometimes yellow. Contractile vacuole single Pedicle rather thick, from three to six times the length of the body Macronucleus long, worm-like

Dimensions —Body-length 110–120 μ, maximum width 61–67 μ

In stagnant water and infusions Social

Remarks —This species resembles *V campanula* in size and general appearance, but is easily distinguishable from that species by a number of differences (1) the animals multiply in bad-smelling infusions, which *V campanula* does not, (2) contracted individuals are not puckered anteriorly, (3) animals are oftener tinted yellow, (4) bell opening is somewhat narrower, and (5) the reserve granules, so abundant in *V campanula*, are here usually absent The thecoplasmic

granules along the spasmoneme have a distribution similar to that of *V campanula*, but occasional larger granules occurring at fairly regular intervals among the smaller ones have been noticed by Noland and Finley The species is often found in

Fig 192

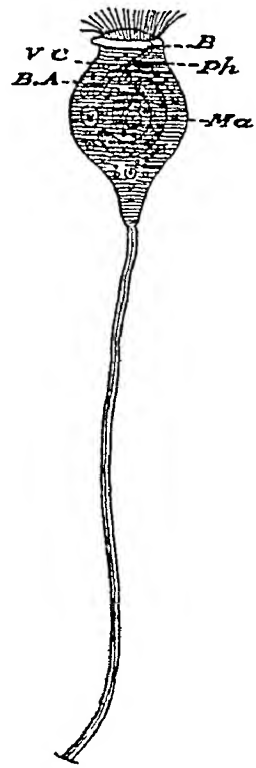


Fig 191

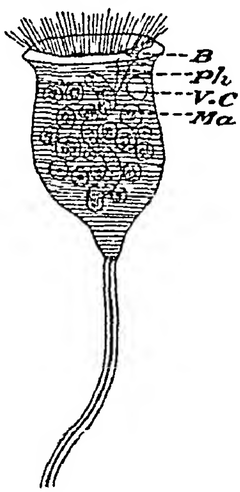


Fig 191 —*Vorticella convallaria* Linn *B*, peristomial groove, *B.A*, cytopharynx, *Ma*, macronucelus, *Ph*, vestibule, *V C*, contractile vacuole (After Roux)

Fig 192 —*Vorticella microstoma* Ehrbg Lettering as in previous figure (After Roux)

the upper layers of vegetable infusions along with *V microstomas*, from which it can be readily distinguished by its thicker stalk and by the body not being narrowed anteriorly

Habitat —Fresh water Bombay

281 Vorticella globosa Ghosh (Fig 196)

†*Vorticella globosa*, Ghosh, 1922 *d*, p 8, pl i, fig iii
Vorticella globosa, Kahl, 1930–5, p 723, fig 137, *30*

Body spherical, with posterior end tapering abruptly to a point, spheroidal when contracted Peristomial margin

half the greatest diameter of the body and raised vertically like a collar Ciliary disc short, discoidal, with a slightly convex upper surface, and about half the peristome in diameter, being attached to one side of the capacious vestibule, which extends towards the aboral pole beyond the middle of the body Surface smooth Endoplasm granular Contractile vacuole placed at the side of the vestibule on the side opposite to the ciliary disc Macronucleus horseshoe-shaped and placed in the middle of the body Pedicle four to five times the length of the body

Dimensions —Length of body 25 μ

Remarks —The length is given as 0 25 mm in the original paper, which is probably an error for 0 025 mm

Habitat —Pond water BENGAL, Calcutta

282 **Vorticella microstoma** Ehrenberg (Fig 192)

Vorticella microstoma, Ehrenberg, 1830, p 66, 1831, p 92; 1838, p 272, pl xxv, fig iii, Dujardin, 1841, p 560, Claparede & Lachmann, 1858–61, p 97

†*Vorticella microstoma*, Carter, 1856*b*, pp 126 247, pl vii, figs 76 78

Vorticella microstoma, Fromentel, 1874, p 236, pl vii, figs 18, 19, Kent, 1880–2, pp 683–4, pl xxxv, figs 9–24, pl xlix, fig 27, Roux, 1901, p 119, pl vii, fig 18 Brand, 1923, pp 61, 69, 73, Lepsi, 1926*a*, p 90, fig 524, Schoenichen, 1927, pp 248–9, pl xiii, fig 26 *a*, & fig 763

†*Vorticella microstoma*, Sandon, 1927, pp 200–1, pl vi, fig 11, Madhava Rao, 1928, p 114, pl iv, fig 1, Chaudhuri, 1929, p 60, pl iii, fig 11

Vorticella microstoma, Noland & Finley, 1931, pp 98, 108, figs 33–44, Kahl, 1930–5, p 729 figs 136, *11* 138, *40*, *40 a*

Body somewhat vase-shaped, broadest in middle and narrowing in the region of the peristome, which is not everted and is about half the maximum width of the body Cuticle with fine transverse striations, specially prominent when body is contracted Colour whitish or greyish Contractile vacuole single Macronucleus long, slender, or somewhat shortened and horseshoe-shaped Pedicle very slender, two or three to five or six times the length of the body

Dimensions —Body-length 60–100 μ, maximum width 32–54 μ

Common in soils and sour infusions

Remarks —Thecoplasmic granules are not visible along the spasmoneme in the living animals "The species shows a great tolerance to bacterial action in infusions In infusions it will sometimes disappear for a few days when bacterial action is at its height, to return again after the decomposition has subsided somewhat" (Noland & Finley) Brand (1923) has studied its encystment

Habitat—Fresh water Bombay, soils from KASHMIR, Srinagar, N W F PROVINCE, Peshawar, PUNJAB, Ghora Gali, CENTRAL INDIA, Indore, MYSORE, MADRAS, Coimbatore

283 **Vorticella patellina Ehrenberg** (Fig 193)

Vorticella patellina (?), O F Müller, 1776, p 281, 1786, p 312
Carchesium fasciculatum, Ehrenberg, 1830, p 41, 1831, p 93 1835, p 165
Vorticella patellina, Lamarck, 1836, p 58, Ehrenberg, 1838, p 273, pl xxvi, fig ii
†*Vorticella patellina*, Grant, 1842
Vorticella patellina, Pritchard, 1861, p 587, pl xxix, fig 1, Fromentel, 1874, p 230, pl v, figs 8–9
Vorticella cratera, Kent, 1880–2, p 679, pl xxxv, fig 26, & pl xlix, fig 15
Vorticella patellina, Lepsi, 1926 *a*, p 91, fig 515, Schoenichen, 1927, p 249, pl xiii fig 26 *d*, Kahl, 1933, p 128, fig 22, *8*, *8 a*, 1930–5, p 733, fig 135, *32*, *33*

Body conical-campanulate in extension, widest at the anterior border, and tapering thence in a straight line to its

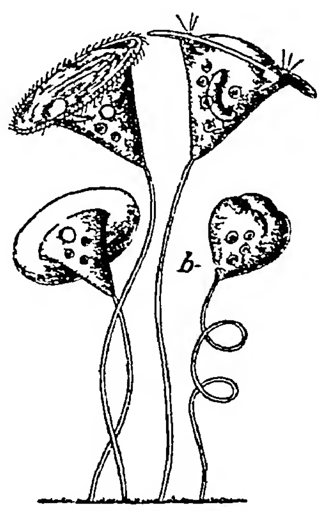


Fig 193 —*Vorticella patellina* Ehrbg *b*, contracted individual (After Ehrenberg)

point of junction with the pedicle, when contracted pyriform, with a puckered anterior margin, the diameter of the expanded frontal border equalling or but slightly less than the total length of the body. Peristome border thin, ciliary disc but slightly elevated Cuticular surface smooth, parenchyma transparent Pedicle slender, three or four times the length of the body, contracting spirally Social

Dimensions—Body-length up to 90 μ

Remarks —*Vorticella patellina*, as originally named and figured by O F Muller, was a marine form Ehrenberg and subsequent writers described a freshwater form as the same species Kent considered the freshwater species to be distinct, and named it *Vorticella cratera* Noland and Finley also consider the marine species described by O F Muller as quite different from *V patellina* of Ehrenberg and Fromentel They, however, think that *V cratera* Kent is not identical with *V patellina* Ehrbg

Habitat —Pond water BENGAL, Calcutta

284 **Vorticella submicrostoma** Ghosh (Fig 194)

†*Vorticella submicrostoma*, Ghosh, 1922 *d*, p 8, pl i, fig i
Vorticella submicrostoma, Kahl, 1930–5, p 727, fig 137, *29*

Body subpyriform, less than twice as long as broad, spherical when contracted, posterior end tapering and conical, body constricted behind the peristome Surface striate transversely Peristomial margin widely everted and slightly less than the greatest body diameter in the middle Ciliary disc moderately and obliquely elevated Vestibule small Cilia long and stout Contractile vacuole large and placed at the base of the ciliary disc Macronucleus horseshoe-shaped, placed in the middle of the body Pedicle stout and less than twice the body-length, sometimes holding the bell slightly inclined

Dimensions —Body-length 76 μ

Remarks —The species, as above described, is not sufficiently distinct from *V microstoma* Ehrbg The length is given as 0 76 mm in the original paper, which is probably an error for 0 076 mm Kahl regards it as only a larger variety of *V octava* Stokes

Habitat —Pond water BENGAL, Calcutta

285 **Vorticella subcylindrica** Ghosh (Fig 195)

†*Vorticella subcylindrica*, Ghosh, 1922 *d*, p 8, pl i, fig ii
Vorticella subcylindrica, Kahl, 1930–5, p 716, fig 137, *5*

Body elongated, cylindrical, about thrice as long as broad and suddenly tapering to a point at the aboral end Peristomial margin slightly everted and raised Ciliary disc slightly elevated Vestibule wide and extending to the middle of the body Contractile vacuole near the lower end of the vestibule Macronucleus band-like and placed in the middle of the body Surface smooth Pedicle narrow and about as long as the body

Dimensions —Body-length, as given by Ghosh, 150 μ (probably an error for 15 μ)

Habitat —Pond water BENGAL, Calcutta

Fig 194

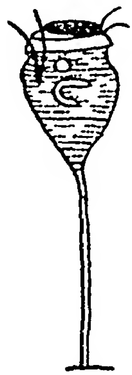


Fig 196

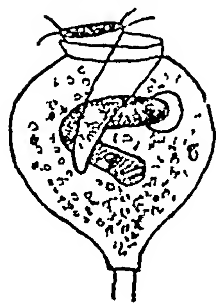


Fig 195

Fig 197

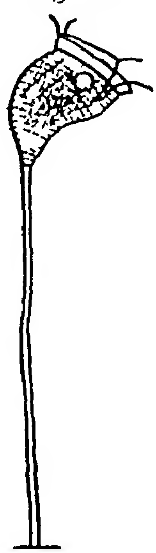


Fig 198

Fig 194 —*Vorticella submicrostoma* Ghosh (After Ghosh)
Fig 195 —*Vorticella subcylindrica* Ghosh (After Ghosh)
Fig 196 —*Vorticella globosa* Ghosh (After Ghosh)
Fig 197 —*Vorticella subprocubens* Ghosh (After Ghosh)
Fig 198 —*Vorticella subsinuata* Ghosh (After Ghosh)

286 Vorticella subprocubens Ghosh (Fig 197)

†*Vorticella subprocubens*, Ghosh, 1922 *d*, p 9, pl i, fig iv
Vorticella subprocumbens, Kahl, 1930-5, p 727, fig 137, *23*

Body curved, obliquely conical-campanulate, widest anteriorly, one and a half times as long as wide Peristomial margin placed obliquely and slightly everted Ciliary disc

slightly elevated Vestibule small Surface striate transversely Pedicle four to five times the body-length.

Dimensions —Body-length, as given by Ghosh, 150 μ (probably an error for 15 μ)

Remarks —Kahl regards it as a doubtful species

Habitat —Pond water BENGAL, Calcutta

287. **Vorticella subsinuata** Ghosh (Fig 198)

†*Vorticella subsinuata*, Ghosh, 1922 *d*, p 9, pl i, fig v
Vorticella subsinuata, Kahl, 1930–5, p 720, fig 137, 7

Body somewhat vase-shaped, widest anteriorly, one and a half times as long as broad somewhat rounded in the middle, with constrictions above and below which separate the middle region from the peristomial margin, and a smaller rounded aboral end respectively Surface smooth Peristomial margin slightly everted Ciliary disc obliquely elevated Vestibule short and wide Pedicle about twice the body in length

Dimensions —Body-length, as given by Ghosh, 150 μ (probably an error for 15 μ)

Habitat —Pond water BENGAL, Calcutta

288 **Vorticella sp**

†*Vorticella* sp, Simmons, 1891, p 4.

Habitat —Pond water BENGAL, Calcutta.

289 **Vorticella sp**

†*Vorticella* sp, Carter, 1856 *b*, pp 235–7, pl vii, fig 75

Habitat —Fresh water BOMBAY

290 **Vorticella sp.**

†*Vorticella* sp, Chaudhuri, 1929, p 60

Habitat —Soils from PUNJAB, Ghora Gali, CENTRAL INDIA, Indore

Genus CARCHESIUM Ehrenberg, 1830

Carchesium, Ehrenberg, 1830, p 41, 1831, p 93, 1838, p 278, Claparède & Lachmann, 1858–61, p 97, Engelmann, 1862, p 389, Stein, 1867, p 168, Fromentel, 1874, p 142, Kent, 1880–2, p 690, Bütschli, 1887–9, p 1764, Roux, 1901, p 120 Lepsi, 1926 *a*, p 87, Schoenichen, 1927, p 251, Reichenow, 1929, p 1210, Kudo, 1931, pp 394–5, Calkins, 1933, p 522, Kahl, 1933, p 131, 1930–5, p 736

Animalcules ovate or pyriform, small to medium-sized, in shape and size resembling those of *Vorticella*, but united in social clusters and forming tree-like colonies through repeated

longitudinal fission, accompanied by a regular or irregular branching of their flexible primary pedicle, the contractile thread within the compound pedicle not continuous throughout, but interrupted at each bifurcation, so as to permit of the independent extension and contraction of the individual zooids Colonies are sometimes more than a millimetre in height Mostly inhabiting clear stagnant water, fixed to débris, leaves, and aquatic plants or animals

Key to Indian Species

1 (2)	Stalk distinctly articulated, body smooth	[p 410 *C epistylis*, Cl & L,
2 (1)	Stalk not articulated, body smooth	*C polypinum* (Linn), [p 412

291 **Carchesium epistylis** Claparède & Lachmann (Fig 199)

Carchesium epistylis, Claparède & Lachmann, 1858–61, pp 99–100, pl i, fig 1
Carchesium epistylidis, Kent, 1880–2, p 692–3, pl xxxvi, figs 12–14
Carchesium epistylis, Roux, 1901, p 121, pl vii, fig 22
†*Carchesium epistylidis*, Bhatia, 1920, p 264
Carchesium epistylidis, Lepsi, 1926 *a*, p 91
Carchesium epistylis, Schoenichen, 1927, p 253, fig 776, Kahl, 1930–5, p 738, fig 139, *17*, *18*

Body campanulate or elongate-conical, very small or small, abruptly narrowed near the point of junction with the pedicle Peristomial border well dilated but not eversible, body not plicate when contracted Cuticular surface smooth or feebly striated transversely Zoodendrium branching subdichotomously, more or less distinctly articulate, such articulations usually occurring immediately beneath each bifurcation Ciliary disc moderately elevated Contractile vacuole single, close to the vestibule Macronucleus band-like, curved, short, transversely disposed, with a small rounded micronucleus placed close to it

Dimensions —Length of the zooids up to 60 μ

Remarks —Numerous colonies were found on the gills, legs and tail-bristles of ephemerid larvæ in pond water at Lahore, each colony consisting of a few (two to four) individuals only The individual zooids were separately contractile, the thread in the stalk being interrupted at each bifurcation The main pedicle was 168 μ in length, stalks supporting individual zooids were three to four times the length of the body, smooth, and during contraction the portion near the body of the zooids was thrown into a spiral Some stalks terminated in two zooids, the stalk just bifurcating near the tip, one portion containing the thread and the other not.

Individual zooids were very small, measuring 32 μ by 26 μ, with the anterior end slightly less wide than the middle of the body. The vestibule extended to about the middle of the body and the peristomial margin was thickened and slightly eversible The contractile vacuole was situated about the middle of the body, and the macronucleus was only slightly

Fig 199

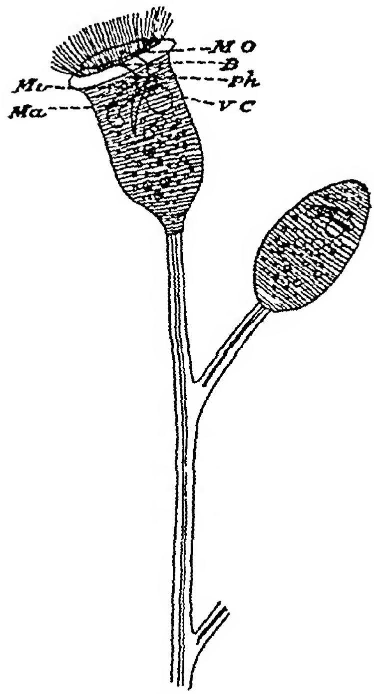


Fig 200

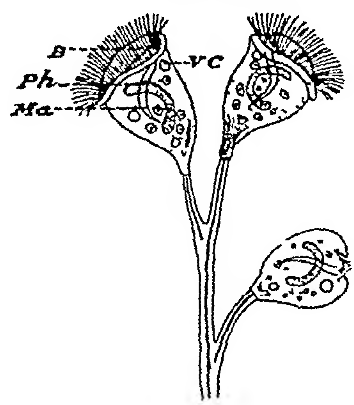


Fig 199—*Carchesium epistylis* Cl & L *B*, peristomial groove, *Ma*, macronucleus, *Mi*, micronucleus, *M O*, adoral zone, *Ph*, vestibule, *V C*, contractile vacuole (After Roux)

Fig 200—*Carchesium polypinum* (Linn) Lettering as in previous figure (After Roux)

curved and somewhat kidney-shaped The contracted zooids were pyriform in shape and the cuticle was smooth

The form encountered differed, however, from the type in lacking the articulate character of the stalk

Habitat—Pond water, attached to ephemerid larvæ PUNJAB, Lahore

292 **Carchesium polypinum** (Linnæus) Ehrenberg (Fig 200)

Vorticella polypina, Linnæus, 1767, p 1317
Carchesium polypinum, Ehrenberg, 1830, p 41, 1831, p 94, 1838, p 278, pl xxvi, fig v
Vorticella ramosissima, Dujardin, 1841, p 551, pl xiv, fig 11
Carchesium polypinum, Claparède & Lachmann, 1858–61, p 98, Fromentel, 1874, p 238, pl vi, fig 1, pl iv, figs 17–20, Kent, 1880–2, pp 690–1, pl xxxv, figs 30, 31, 51, pl xxxvi, figs 1–8, Butschli, 1887–9, pl lxxiv, fig 1, *a–b*, Roux, 1901, p 122, pl vii, fig 24
†*Carchesium polypinum*, Annandale, 1907, pp 37–38
Carchesium polypinum, Enriques, 1908, pp 270–2
Carchesium corymbosum, Penard, 1922, pp 260–2, figs 246, 247
Carchesium polypinum, Bullington, 1925, p 270, Lepsi, 1926 *a*, p 91, fig 540, Wenyon, 1926, fig 528, Schoenichen, 1927, p 253, pl xiii, fig 27
†*Carchesium polypinum*, Madhava Rao, 1928, p 114
Carchesium polypinum Reichenow, 1929, p 1210, fig 1191, Kudo, 1931, p 395, fig 169, *k*, Calkins, 1933, p 38, fig 102, Kahl, 1930–5, pp 738–9, fig 139, *19, 20*

Body campanulate, or more or less conical, broadly expanded in front Peristomial border everted and recurved Cuticular surface smooth Contractile vacuole single, close to the vestibule Macronucleus curved, forming an arc in the longitudinal plane Compound pedicle branching, non-articulate and smooth Colonies composed sometimes of an immense number of individuals, frequently attaining a height of 2 to 3 millimetres

Dimensions —Length of individuals 60–65 μ, width anteriorly 42–44 μ

Habitat —Brackish and freshwater ponds BENGAL, Port Canning Soil MYSORE

293 **Carchesium** sp, Simmons

Carchesium sp, Simmons, 1891, p 4

Habitat —Pond water BENGAL, Calcutta

3. Family EPISTYLIDÆ Kahl 1933.

Stalked forms, with the stalk not provided with myoneme thread, and consequently rigid

Genus EPISTYLIS Ehrenberg, 1830

Epistylis, Ehrenberg, 1830, p 41, 1838, p 279, Dujardin, 1841, p 539, Stein, 1867, pp 135, 168, Claparède & Lachmann, pp 1858–61, p 107, Engelmann, 1862, p 390, Fromentel, 1874, p 143, Kent, 1880–2, p 700, Bütschli, 1887–9, p 1766, Roux, 1901, p 123, Lepsi, 1926 *a*, p 87, Wenyon, 1926, p 1223, Schoenichen, 1927, p 254, Reichenow, 1929, p 1211, Kudo, 1931, p 395, Calkins, 1933, p 522, Kahl, 1933, p 125, 1930–5, p 680

Animalcules campanulate, ovate or pyriform, very small to medium-sized, corresponding structurally with those of *Vorticella*, attached in numbers to a rigid, uncontractile, more or less branching, tree-like pedicle, the zooids usually of similar size and shape Ciliary disc little elevated Peristomial border thickened, rarely eversible Anterior part expanded, though slightly Vestibule normally developed Contractile vacuole single Macronucleus variable in form Colonies sometimes of numerous individuals and reaching several millimetres in height Inhabiting salt and fresh water, attached to aquatic plants or animals

Key to Indian Species

1		Stalk not wrinkled transversely	2
2	(7)	Stalk articulated at distant intervals	3
3	(5)	Stalk longitudinally striated	4
4		Body elongate-conical, cuticular surface smooth, length of zooids 77–126 μ	*E articulata* From, [p 414
5	(3)	Stalk not longitudinally striated	6
6		Body elongate conical, cuticular surface smooth, exhibiting transverse folds posteriorly when contracted, length of zooids 208 μ Colonies of many individuals	*E galea* Ehrbg, p 416
7	(2)	Stalk not articulated	8
8	(10)	Stalk with fine longitudinal striæ	9
9		Body elongate conical, cuticular surface soft and flexible, plicate, or exhibiting several annular folds posteriorly when contracted, length of zooids 90–150 μ	*E plicatilis* Ehrbg, [p 417
10	(8)	Stalk not longitudinally striated	11

11. Body conical campanulate, three times as long as broad, anterior end wider, cuticular surface smooth or finely striate transversely, length of zooids 89 μ [p 414
E anastatica (Linn),

294 Epistylis anastatica (Linnæus) Ehrenberg (Fig 204)

Vorticella anastatica, Linnæus 1767, p 1317 , Müller, 1773, p 139, 1786, pl xliv, fig 10 , pl xlvi, fig 5 , pl xxxviii, fig 18 Ehrenberg, 1830, p 41 , 1831, p 96 , 1838, p 281, pl xxvii, fig ii , Fromentel, 1874, p 242, pl ix, figs 5, 6, 6 *a* , Kent, 1880–2, p 701, pl xxxviii, figs 19–22
†*Epistylis anastatica*, Daday, 1898, p 9
Epistylis anastatica, Lepsi, 1926 *a*, p 93 , Kahl, 1930–5, p 689 fig 131, *14–16*

Bodies conical-campanulate, nearly three times as long as broad, attenuate posteriorly, frontal margin dilated, with a snout-like projection when contracted Cuticular surface smooth or finely striate transversely Ciliary disc raised Pedicle moderately thick, entirely smooth, neither striate nor articulate, branching profusely and dichotomously, secondary branches attenuate, equal to or exceeding the length of the zooids

Dimensions —Length of zooids 89 μ, height of entire colony 1 6 mm

Habitat —Fresh water, on Copepods CEYLON

295 Epistylis articulata Fromentel (Fig 202)

Epistylis articulata, Fromentel, 1874, p 242, pl ix, fig 3 , Kent, 1880–2, pp 707–8, pl xxxix, fig 3
†*Epistylis articulata*, Bhatia, 1920, p 265
Epistylis articulata, Lepsi, 1926 *a*, p 92 , Kahl, 1930–5, p 685, fig 131, *22*

Bodies elongate-conical, tapering posteriorly, somewhat gibbous, nearly three times as long as broad Cuticular surface smooth , peristome border slightly dilated , ciliary disc moderately elevated , vestibular seta conspicuously developed. Pedicle dichotomous, short, stout, and sparingly branched, striate longitudinally, articulate at one or two intervals between each bifurcation

Dimensions —Length of zooids 77–126 μ

Remarks —Found growing abundantly on all sides of a small spirally coiled gastropod shell (probably *Planorbis*), on which it formed a white fluffy mass, at Lahore The colonies were erect and the height of a colony was 595 μ The pedicle was dichotomous, sparingly branched, striate longitudinally, articulate at one or two intervals between each bifurcation,

in which respect this species differs from *E. plicatilis*. The body was three to four times as long as broad, individual zooids in a fully extended condition measuring from 105 to 126 μ in length and 26 to 31 μ in width. The body form was as in *E. plicatilis*, but there were two zooids at the termination of each stalk.

Kent, in a note to the description of this species, remarks:— "In shape the animalcules of this species appear to closely resemble those of *E. plicatilis*, and it is a question whether

Fig. 201.

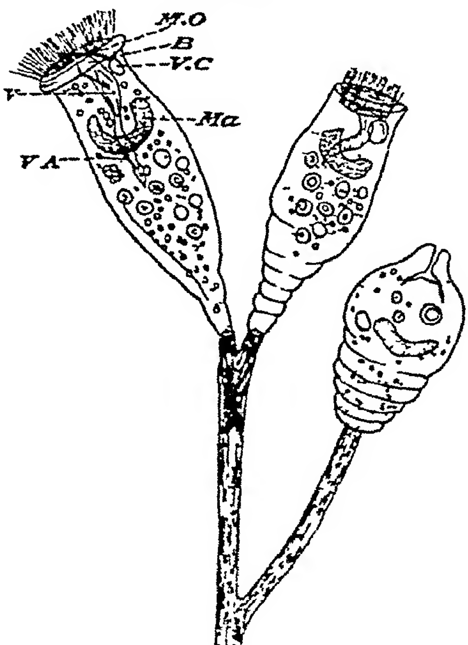


Fig. 202

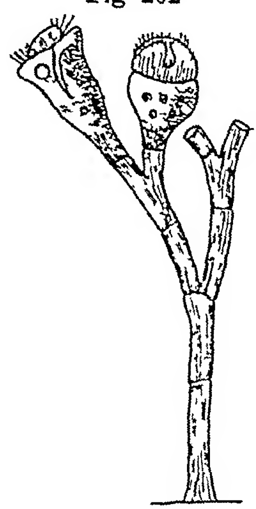


Fig. 201.—*Epistylis plicatilis* Ehrbg. *B*, peristomial groove; *Ma*, macronucleus; *M.O*, adoral zone; *V*, vestibule; *V.A*, food-vacuole; *V.C*, contractile vacuole. (After Roux.)
Fig. 202.—*Epistylis articulata* From. (After Kent.)

the chief point of difference cited by Dr. Fromentel, that of the articulation at distant intervals of the pedicle, is sufficient to distinguish them, more especially as, in the last-named form, Stein has remarked that old specimens are similarly jointed. No mention is made as to the form assumed by the zooids when in a state of contraction, which would have been useful in the settlement of this supposed identity, nor as to whether the species forms large or small colonies."

I am able to throw some light on this disputed point, having observed the zooids in the contracted condition. Tl

form assumed by the contracted zooids is globular, the posterior part showing transverse furrows as in *E plicatilis* The size of the colony, which is considerably smaller than that of *E plicatilis*, and the presence of two zooids perched at the termination of each stalk, along with the articulate character of the stalk, which is a constant feature in one and a rare feature in the other, serves to distinguish the two species

Habitat —Fresh water, growing on gastropod shells PUNJAB, Lahore

296 **Epistylis galea** Ehrenberg (Fig 203)

Epistylis galea, Ehrenberg, 1831, p 97 , 1838, pp 280–1, pl xxvii, fig 1
†*Epistylis galea* (?), Carter, 1856 *b*, p 247, pl vii, fig 74
Epistylis galea, Fromentel, 1874, p 243, pl xi, fig 2 , Kent, 1880–2, p 701, pl xxxix, fig 6 , Lepsi, 1926 *a*, p 92 , Kahl, 1930–5, p 691, figs 131, *27* , 133, *19*

Bodies elongate-conical, about three times as long as broad, attenuate posteriorly, the frontal margin dilated Cuticular

Fig 203

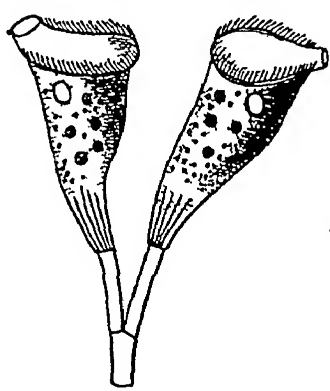


Fig 204

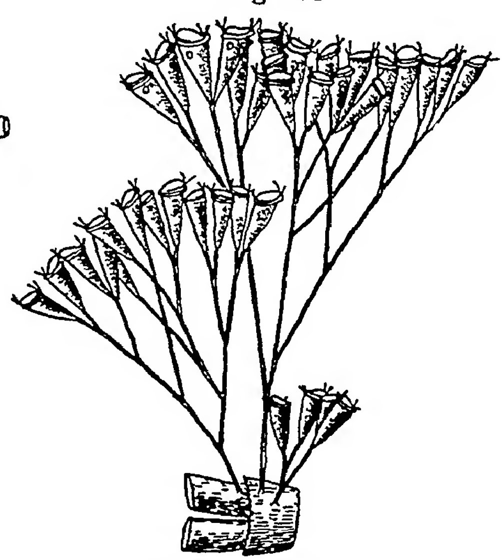


Fig 203 —*Epistylis galea* Ehrbg (After Kent)
Fig 204 —*Epistylis anastatica* (Linn) (After Kent)

surface smooth, exhibiting transverse folds posteriorly when contracted Vestibular entrance prominent, projecting laterally in a spout-like manner Zoodendrium relatively short thick, profusely and dichotomously branched , secondary

branches not exceeding the zooids in length, articulate at each bifurcation

Dimensions—Length of bodies 208 μ, height of entire colony 1 mm

Habitat—Fresh water on aquatic plants. BOMBAY

297 **Epistylis plicatilis** Ehrenberg (Fig 201)

Epistylis plicatilis, Ehrenberg, 1831, p 96, 1838, pp 281–2, pl xxviii, fig 1, Dujardin, 1841, p 542, pl xvi, fig 4, Claparède & Lachmann, 1858–61, p 110, Fromentel, 1874, pp 241–2, pl viii, figs 5–16, pl xi, figs 1, 5, Kent, 1880–2, pp 701–2, pl xxxviii, figs 6–8, pl xxxix, figs 12–15, Roux, 1901, p 123, pl viii, fig 3, Schroeder, 1906, pp 173–85, pl vi
†*Epistylis plicatilis*, Bhatia, 1920, p 264
Epistylis plicatilis, Lepsi, 1926 *a*, p 92, Schoenichen, 1927, p 257, fig 780, pl xiii, fig 31, Kahl, 1930–5, p 690, fig 131, *17*, *18*

Bodies elongate-conical, attenuate posteriorly, three or four times as long as broad Cuticular surface soft and flexible, when contracted plicate or exhibiting several annular folds posteriorly. Peristomial margin dilated, the ciliary disc much elevated Pedicle slender, finely striate longitudinally, profusely and dichotomously branched, zooids of the colony all reaching the same level Colony of large numbers, attaining up to 3 mm in height

Dimensions—Length of zooids 90–150 μ

Remarks—Colonies were found forming whitish tufts on shells of a snail (probably *Limnæa*) in pond water, Lahore. The colonies were long, dichotomously branching, and the individual zooids were independently contractile, there being no thread running in the stalks The secondary branches of the stalk showed longitudinal striations at the attachment of the zooid, but were otherwise granular and somewhat feathery in appearance The length of the expanded zooids was 84–126 μ The peristomial margin was dilatable, and the ciliary disc capable of considerable projection in the fully extended condition of the animal When the zooid was contracted there was an anterior projection, and the posterior half of the body showed the distinct transverse pleating which is characteristic of the species

Habitat—Fresh water, attached to the shells of molluscs (*Limnæa* sp) and various water-plants PUNJAB, Lahore

298 **Epistylis sp**

Epistylis sp, Simmons, 1891, p 4

Habitat—Pond water · BENGAL, Calcutta.

2. Tribe LORICATA Kahl, 1933.

PERITRICHA possessing a test or lorica

Family VAGINICOLIDÆ Kent, 1881.

Forms with tests or houses, which may or may not be stalked

Key to Indian Genera

1 (7)	Test with or without stalk, not attached by its broad side to the substratum	2	
2 (5)	Test without an operculum, remaining open during contraction	3	
3 (4)	Test with stalk	COTHURNIA Ehrbg ,	[p 418
4 (3)	Test without stalk, attached directly to a submerged object by its posterior end	VAGINICOLA Ehrbg ,	[p 419
5 (2)	Test closed during contraction by an operculum or stopper	6	
6	Test closed by a pseudochitinous cover	PYXICOLA Kent,	[p 419
7 (1)	Test attached by its broad side to a submerged object, and the animal has a more or less distinct, somewhat ascending neck	PLATYCOLA Kent,	[p 420

Genus COTHURNIA Ehrenberg, 1831, emend Claparède & Lachmann, 1858

Cothurnia Ehrenberg, 1831, p 94 , 1838, p 297 , Stein, 1849, pp 106–7 , 1867, p 168 , Claparède & Lachmann, 1858–61, p 121 , Fromentel, 1874, p 147 , Kent, 1880–2, p 719 , Butschli, 1887–9, p 1769 ; Roux, 1901, p 132 , Lepsi, 1926, p 87 , Schoenichen, 1927, p 263 , Reichenow, 1929, p 1211 , Kudo, 1931, p 397 , Calkins, 1933, p 522 , Kahl, 1933, p 135 1930–5, p 769

Animalcule surrounded by a wide pseudochitinous lorica, which is usually attached to a submerged object by a very short and very thin stalk Animalcule can withdraw itself into the lorica Form of the lorica variable, but remaining open during contraction Structure of the body as in other Vorticellids Body elongated, narrow behind, especially in a state of complete extension Very contractile Inhabiting salt or fresh water, attached to aquatic plants

299 **Cothurnia** sp

†*Cothurnia* sp , Simmons, 1891, p 4

Habitat —Pond water BENGAL, Calcutta

Genus VAGINICOLA (Lamarck, 1816), emend Claparède & Lachmann, 1858

Vaginicola, Lamarck, 1816, ii, p 26
Vaginicola, part, Ehrenberg, 1838, p 295 , Dujardin, 1841, p 560 , Stein, 1849, pp 106–22
Vaginicola, Claparède & Lachmann, 1858–61, p 126 , Fromentel, 1874, p 149 , Butschli, 1887–9, p 1770 , Lepsi, 1926 *a*, p 87 , Schoenichen, 1927, p 265 , Reichenow, 1929, p 1211 , Kudo, 1931, p 398 , Calkins, 1933, p 522 , Kahl, 1933, p 133 , 1930–5, p 759

Body elongated, club-shaped and changeable in form, with the hinder end attached at the bottom of a wide, transparent lorica, which is without stalk and is attached directly to a submerged object by its posterior end Structure of the body like that of other Vorticellids

300 **Vaginicola** sp

†*Vaginicola* sp , Simmons, 1891, p 4

Habitat —Pond water BENGAL, Calcutta

301 **Vaginicola** sp

†*Vaginicola* sp , Mitchel, 1862, p 60

Remarks —The form is described as resembling *V crystallina* closely, differing only by its somewhat larger size and absence of green granules The animal, when feeding, generally had the anterior half of the body at right angles to the sheath The sheath was provided with a valve, which makes it probable that the species was not correctly identified

Habitat —Attached to a common water-weed in a small tank Bangalore

Genus PYXICOLA Kent, 1881

Pyxicola, Kent, 1880–2, p 725
Cothurnia, part, Butschli, 1887–9, p 1769
Pyxicola, Kahl, 1933, p 139 , 1930–5, p 787

Animalcules elongated, with the hinder end attached directly or by a short stalk to the bottom of a transparent lorica, which is borne on a short stalk The anterior end of the body

a stalk, often showing a distinct neck-like constriction anteriorly Anterior part of the body protruding at right angles to the axis of the lorica Structure of the body like that of other Vorticellids

303 **Platycola** sp

†*Platycola* sp , Simmons, 1891, p 4

Habitat —Pond water BENGAL, Calcutta.

IV. Order CHONOTRICHA Wallengren.

A small group of forms in which the sessile mode of life has been carried to a high degree of specialization These ecto-parasites of Crustacea possess anteriorly a funnel-shaped peristome, in the bottom of which parallel ciliary rows run in a clock-wise direction (unlike the PERITRICHA) to the mouth Other body cilia absent Reproduction by budding The bud detaches itself as an irregularly shaped swimming organism which shows no relationship with the PERITRICHA, a group with which these forms were previously united The swimming bud attaches itself to the host and develops into the adult

Identification Table of Families

1 Peristomial area with the adoral zone of membranelles is spirally rolled Individuals sessile, with or without a stalk	**Spirochonidæ** * Stein
2 Peristomial area formed by two projecting lips	**Chilodochonidæ** * Poche

Up to the present time no animals belonging to either of the families in the order have been discovered in India

Class II. SUCTORIA Butschli.

(*Syn* TENTACULIFERA or ACINETARIA)

The members of this class are distinguished from the CILIATA by the cilia being present only in the young stages, which are free-swimming embryos budded off from the adult The adult organisms are sedentary, do not bear any cilia, but develop suctorial tentacles, by means of which they imbibe nourishment from the objects or organisms to which they adhere There is no cytostome One or more contractile vacuoles are usually present The nuclear apparatus resembles that of the EUCILIATA, as both macronuclei and micronuclei are present The macronucleus exhibits a great variety of form In the colonial form *Dendrosoma* it is branched in the same manner as the colony and extends continuously throughout it

The form of the body varies greatly, being typically vase-like, with or without a stalk or peduncle In sessile forms the body is attached by a broad base to the substratum The organisms are attached to algæ, the bodies of small Crustacea, aquatic larvæ, or other objects A few are unattached, and are parasitic on free-living or parasitic ciliates The body is often protected by a secreted theca, continuous with the stalk in pedunculate forms

The tentacles are stiff processes, the ectoplasm forming a tube enclosing a canal containing fluid and the apex terminating in a sucker-like knob These sucking tentacles are always present in the adult organism In addition, in *Ephelota* there are prehensile tentacles, which end in a point

Reproduction may be by binary fission, but usually is by budding Budding may be external, one or more buds being formed on the surface of the organism, or internal, in which case the buds are formed in a deep depression of the surface of the body, called a brood-pouch (fig 206) These buds develop cilia, and the ciliated embryos move about within the sac, and finally come out through a pore and swim away. After swimming

about for some time an embryo becomes attached to a suitable object, loses its cilia, develops tentacles, and grows into the adult pedunculate form.

Details of conjugation are known in a few forms As in the CILIATA, when two organisms associate the macronuclei degenerate and the micronuclei divide a number of times Exchange and union of micronuclei takes place, and the organisms then separate Macronuclei and micronuclei are re-formed from the products of division of the combination nucleus

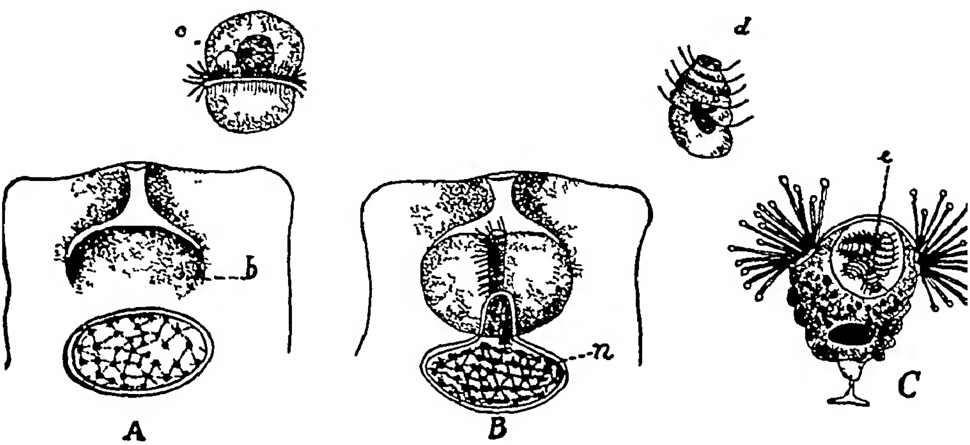


Fig 206—Endogenous budding in Suctoria A, B, two stages in the formation of a bud (*b* and *c*) of *Tokophrya quadripartita*, C, *Acineta tuberosa* with endogenous buds (*e* and *d*) (From Calkins, after Butschli)

Collin (1912), in his monograph on the group, has divided the class into eight families, of which Hypcomidæ Butschli has been transferred to the HYMENOSTOMATA by Reichenow Of the remaining seven families representatives of only two are known from India so far

Identification Table of Families

1 (2)	Prehensile tentacles in addition to suctorial tentacles	**Ephelotidæ** * Sand
2 (1)	Without prehensile tentacles, suctorial tentacles alone present	3
3 (8)	Body not bilaterally symmetrical, irregular or branched	4
4 (5)	Without "proboscis" or special "arms"	[Bütschli **Dendrosomidæ** *

5 (4)	With retractile " proboscis " or special " arms "	6 [Stein
6 (7)	With retractile " proboscis "	Ophryodendridæ *
7 (6)	With special, tentacle bearing " arms "	Dendrocometidæ *
8 (3)	Body monaxial, more or less bilateral	9 [Stein
9 (10)	Reproduction by external budding	Podophryidæ Butschli,
10 (9)	Reproduction by internal budding	11 [p 429
11 (12)	Stalk short, thick Pellicle coriaceous and tough Without test or lorica Tentacles thick-set, knobbed	Discophryidæ * Collin
12 (11)	Pellicle delicate Naked or enclosed in tests Tentacles thin, knobbed	[p 425 Acinetidæ Butschli,

1. Family ACINETIDÆ Butschli, 1889.

Forms generally showing a bilateral symmetry Only suctorial tentacles are present Individuals are naked or in tests, and with or without a stalk Reproduction by division or by endogenous budding Many are ectoparasitic on the gills of fresh- or salt-water animals, some are endoparasites and are devoid of stalks and tentacles

Key to Indian Genera

1	With tentacles, not parasitic inside Infusoria	2
2 (3)	Without test, body pyramidal, with stalk, tentacles in fascicles	[Collin, p 425 TOKOPHRYA (Bütsch)
3 (2)	With test, test without free margin, membrane like, stalked	[Collin, p 428 ACINETA (Ehrbg)

Genus TOKOPHRYA (Butschli, 1889) Collin, 1911

Acineta, part, Ehrenberg, 1838, p 240, Stein, 1854
Podophyra, part, Stein, 1854, Claparède & Lachmann, 1858–61, p 382, Kent, 1880–2, p 813
Tokophrya, Butschli, 1887–9, p 1928, Sand, 1901, p 242, Collin, 1911 *b*, pp 425–40, 1912, pp 330–6, Schoenichen, 1927, p 269
Tocophrya, Reichenow, 1929, p 1215
Tokophrya, Kudo, 1931, p 404, Calkins, 1933, pp 228, 523

Body pyriform or pyramidal Without lorica Suctorial tentacles arranged in bundles, one to four in number, all springing from the frontal surface Stalk delicate and of uniform thickness along its whole length Ciliated embryos egg-shaped, and generally monaxially symmetrical, laterally with an adoral zone Birth-opening on the lateral surface of the older individuals

Key to Indian Species

1	Pedicle elongated, tentacles in bundles	2
2 (3)	Tentacles in four bundles, macronucleus oval	*T quadripartita* (Cl & [L), p 427
3 (2)	Tentacles in two bundles, macronucleus pyramidal	*T bengalensis* Ghosh, [p 426

304 **Tokophrya bengalensis** Ghosh (Fig. 207)

†*Tokophrya bengalensis*, Ghosh, 1929 c, p 222, fig 1

Body more or less pyramidal, length equalling the diameter of the base, with a cup-like depression at the narrow fixed end Two rounded bosses at the free end, each supporting ten to

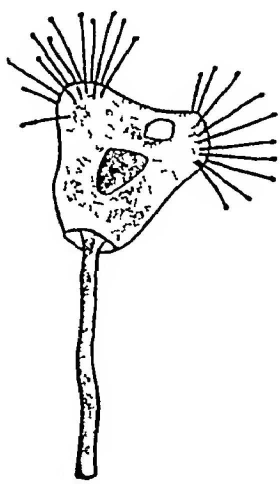


Fig 207 —*Tokophrya bengalensis* Ghosh (After Ghosh)

twelve tentacles Tentacles subequal and half the body or more in length Contractile vacuole single, close to one of the two anterior bosses Macronucleus irregularly pyramidal, central Micronucleus not detected Pedicle cylindrical, slightly widened at its junction with the body, and about one and one-half times as long as the body

Dimensions—Length of the body, as given in Ghosh's paper, is 75 mm (probably an error for 75 μ)

Remarks—The species resembles *T cyclopum* (Clap & Lachm) and *T infusionum* (St) in having two bundles of tentacles, but differs in possessing a long stalk and a pyramidal macronucleus

Habitat—Sewer water BENGAL, Calcutta

305 **Tokophrya quadripartita** (Claparède & Lachmann) (Fig 208)

Podophrya quadripartita, Claparède & Lachmann, 1859–61, p 382, 1861, pp 116–22
Acineta phase of *Stylonychia* and *Urostyla*, Stein, 1859 *d*, pp 52, 103
†*Podophrya quadripartita*, Carter, 1865, p 287
Podophrya quadripartita, Kent, 1880–2, p 820, pl xlvi, fig 18
Tokophrya quadripartita Butschli, 1887–9, p 1928, pl lxxvii, fig 9, Schewiakoff, 1893, p 151, Sand, 1901, p 263, pl vi, fig, 6, Filipjev, 1911, pp 117–42, 1 text-fig, pl viii, Collin, 1911 *b*, pp 433–8, fig ii, pl x, figs 15–19, 1912, p 331, pl v, fig 96, Schoenichen, 1927, p 270, fig 802, pl xiii, fig 47
Tocophrya quadripartita, Reichenow, 1929, p 1216, fig 1195
Tokophrya quadripartita, Calkins, 1933, pp 22, 228, figs 3 *e*, 107

Body in the form of a quadrangular pyramid, tapering posteriorly, anterior extremity divided into four blunt lobes,

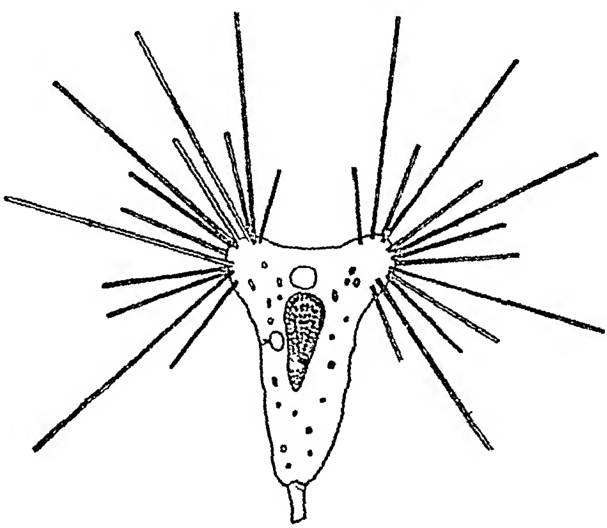


Fig 208 —*Tokophrya quadripartita* (Cl & L) Only a portion of the pedicle is shown (After Filipjev)

each of which bears a fascicle of tubular sucking-tentacles Pedicle thin, cylindrical, from one to one and a half times the length of the body Contractile vacuoles varying in number from one to six Macronucleus oval, central

Dimensions —Length of body 80–110 μ

In fresh water, on *Epistylis plicatilis* or attached to water-plants or *Paludina* and other freshwater molluscs

Habitat —Fresh water BOMBAY

Genus ACINETA (Ehrenberg), Collin

Acineta, Ehrenberg, 1833, p 284, 1838, p 240, Claparède & Lachmann, 1858–61, p 387, Kent, 1880–2, p 828, Butschli, 1889, p 1929, Sand, 1901, p 268, Collin, 1912, pp 636–48, Schoenichen, 1927, p 271, Reichenow, 1929, p 1215, Kudo, 1931, p 404, Calkins, 1933, p 523, Kahl, 1934, p 207

Animalcules solitary, conical or cylindro-conical, secreting a protective lorica, wholly or partly enclosing the organism Lorica supported on a rigid, more or less extensively developed pedicle Tentacles suctorial, capitate, variously distributed Macronucleus rounded or elongated Budding usually only endogenous Ciliated embryo with ciliary girdle or complete ciliary coat Inhabiting salt and fresh water

306 Acineta tuberosa Ehrenberg (Fig 209)

Acineta tuberosa Ehrenberg, 1833, p 285, 1838, p 241, pl xx, fig x

†*Acineta tuberosa*, Carter, 1865, p 287

Acineta tuberosa, Kent, 1880–2, p 829, pl xlviii, figs 25–8, pl xlviii A, fig 7, Butschli, 1887–9, p 1929, pl lxxviii, figs 1 *a–f* & *h*, Schewiakoff, 1893, p 151, Sand, 1901, pp 307–11, pl vii, figs 4–6, 11–14, pl xii, fig 9, pl xiii, figs 3–5, 7, pl xvi, fig 14, Collin, 1912, pp 337–40, figs lxxxii–lxxxiv, Reichenow, 1929, fig 1193 *a*, Kudo, 1931, p 404, fig 173 *g*, Calkins, 1933, p 228, fig 117 c, Kahl, 1934, p 209, figs 6, *1–9*, *11–23*

Lorica compressed, subtriangular, widest at its distal margin, and thence tapering gradually towards its point of

Fig 209 —*Acineta tuberosa* var *fœtida* Sand, Collin *a*, showing endogenous buds, *b*, free swimming embryo (From Calkins, after Butschli)

junction with the pedicle, the lateral walls continuous over the frontal border, leaving two ovate apertures at the anterior angles for the extrusion of the tentacles Pedicle slender, rectilinear, varying from equal up to as much as four or five times the length of the lorica Body of the animalcule mostly attenuate posteriorly, rarely filling the cavity of the lorica except towards the anterior border, invariably adherent to it

by its posterior extremity, in the region of the tentacles, and usually along four lines extending from the posterior extremity towards the anterior border, such lines of adhesion communicating to the body, as seen in vertical optical section, a distinct quadrilateral contour. Tentacles forming two antero-lateral fascicles, protruding, when extended, through the corresponding oval apertures in the lorica, withdrawn in a sheaf-like manner into the substance of the body by invagination when retracted. Macronucleus elongate-ovate or cord-like, often contorted and branched.

Dimensions.—Length of lorica 50–100 μ.

Remarks.—Three distinct varieties of this species are recognized. In *A. tuberosa* Ehrbg. var. *fraiponti* Sand, Collin the pedicle varies from two to five times the height of the body; but in *A. tuberosa* forma *brevipes* Collin and *A. tuberosa* var. *fœtida* Sand, Collin the pedicle is less than the height of the body.

Habitat.—Fresh water. BOMBAY.

2. Family PODOPHRYIDÆ Butschli, 1889.

Forms generally showing a bilateral symmetry. Only suctorial tentacles are present, over the entire body or grouped in fascicles. Individuals are naked or enclosed in delicate and close-fitting or coarse and loose-fitting test. Reproduction by division or by exogenous budding. Free-living or parasitic.

Key to Indian Genera.

1.	Without test or cup	2. [Butsch., p. 429.
2 (3).	Normally with stalk, attached	PODOPHRYA (Ehrbg.)
3 (2).	Free swimming or parasitic	SPHÆROPHRYA Clap. & [Lach., p. 433.

Genus PODOPHRYA (Ehrenberg, 1833) emend. Butschli, 1889.

Podophrya Ehrenberg, 1833, p. 306; 1838, p. 305; Claparède & Lachmann, 1858–61, p. 382; Carter, 1865, p. 287; Kent, 1880–2, p. 813; Bütschli, 1887–9, p. 1927; Sand, 1901, p. 217; Collin, 1912, pp. 396–401; Schoenichen 1927, p. 289; Reichenow 1929, p. 1217; Kudo, 1931, p. 402; Calkins, 1933, p. 524; Kahl, 1934 p. 198.

Body form somewhat spherical, without lorica; knobbed tentacles arising from the whole of the surface. Length of the

stalk varying greatly Contractile vacuole usually single Macronucleus oval, central Multiplication by fission into nearly equal parts, ciliated embryo provided with a broad ciliary girdle Salt and fresh water

Key to Indian Species

1 (4)	Body nearly spherical, pedicle less than the diameter of the body	2
2 (3)	Macronucleus elongate oval or kidney-shaped Contractile vacuoles 1 or 2	*P fixa* (O F Müll) [Ehrbg, p 431
3 (2)	Macronucleus spherical Contractile vacuole absent	*P bengalensis* Ghosh, [p 430
4 (1)	Body pyriform, pedicle longer than the body Macronucleus oval or spherical, contractile vacuole eccentric	*P sandi* Collin, p 432

307 **Podophrya bengalensis** Ghosh (Fig 210)

†*Podophrya bengalensis* Ghosh, 1929 c p 223, fig 2

Body subspherical Pedicle cylindrical, slightly dilated at its proximal end, and nearly two-thirds the diameter of the

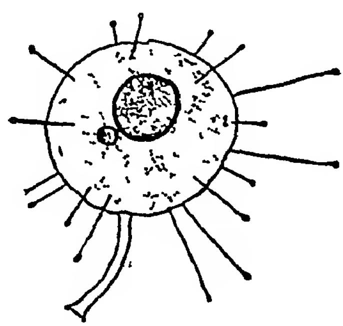


Fig 210 —*Podophrya bengalensis*, Ghosh (After Ghosh)

body in length Tentacles cylindrical, straight, capitate, unequal in length, less than the body diameter in length, arranged radially, seventeen in number Cytoplasm finely granular No contractile vacuole Macronucleus spherical, subcentral

Dimensions —Diameter of the body as given in Ghosh's paper is 32 mm (probably an error for 32 μ), length of the pedicle 22 mm (probably an error for 22 μ)

Habitat —Sewer water BENGAL, Calcutta

308 **Podophrya fixa** (O F Muller) Ehrenberg (Fig 211)

Trichoda fixa, O F Muller, 1786, p 217, pl xxx, figs 11–12
Podophrya fixa, Ehrenberg, 1833, p 306, 1838, p 306, pl xxxi, fig x
Actinophrys pedicellata, Dujardin, 1841, 266
Actinophrys sol, part, Stein, 1849, pp 133, 147, 148, 1854, pp 140–50
Acineta phase of *Vorticella microstoma*, Stein, 1849, pp 142–5
Podophrya fixa Claparède & Lachmann, 1858–61, p 384
†*Podophrya fixa*, Carter, 1865, pp 287–8, pl xii, figs 9 *e*, 10 *d*
Podophrya fixa, Kent, 1880–2, p 813, pl xlvi, figs 24–30, Schewiakoff, 1893, p 151, Sand, 1901, pp 223–4, Collin, 1912, pp 396–7, pl i, figs 13, 14 Schoenichen, 1927, p 289, fig 819, Reichenow, 1929, p 1217, Kudo, 1931, p 402, fig 172, *d*, *e*, Calkins, 1933, pp 81, 480, figs 43, 198, Kahl, 1934, p 198

Body spherical Pedicle slender and usually sinuous, with its distal extremity abruptly expanded, its length rarely

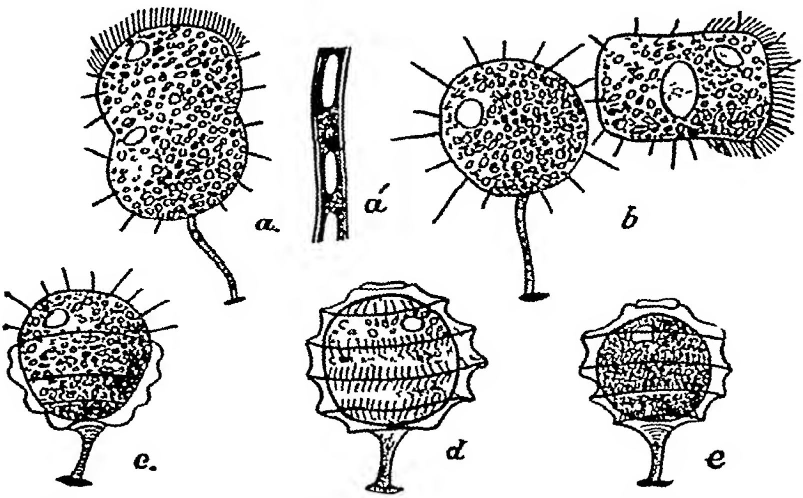


Fig 211 —*Podophrya fixa* (O F Müll) *a*, animal showing commencement of budding, *a'*, stalk highly magnified, *b*, setting free of the embryo, *c*, beginning of encystment, *d* & *e*, cysts (From Schoenichen, after Collin)

exceeding the diameter of the body Tentacles numerous slender, distinctly capitate, not exceeding the body-length, distributed throughout the surface of the periphery Contractile vacuole single or double Macronucleus elongate-oval or kidney-shaped, subcentral Cysts barrel-shaped, with three or four prominent transversely annular crests or ridges

Dimensions —Length of the body 50–72 μ

Habitat —Fresh and salt water Bombay

309 **Podophrya sandi Collin** (Fig 212)

Acineta gelatinosa, Buck, 1884, pp 298–304
Trichophrya gelatinosa, Schewiakoff, 1893
Podophrya sp, Maupas, 1881, p 305, pl xix, fig v
†*Podophrya* sp, Simmons, 1889, p 145
Podophrya gelatinosa Sand, 1901, pp 224–6, pl vi, figs 9, 11, pl x, figs 8–13, pl xviii, figs 8, 11, 13, pl xxiii, fig 9
Podophrya sandi, Collin, 1912, pp 398–401, fig cv, Schoenichen, 1927, p 291, fig 820

Pedicle straight, inserted on a conical prolongation of the body, which gives it a pyriform appearance Tentacles numerous, unequal, knobbed, not exceeding in length three times the diameter of the body, uniformly distributed or in

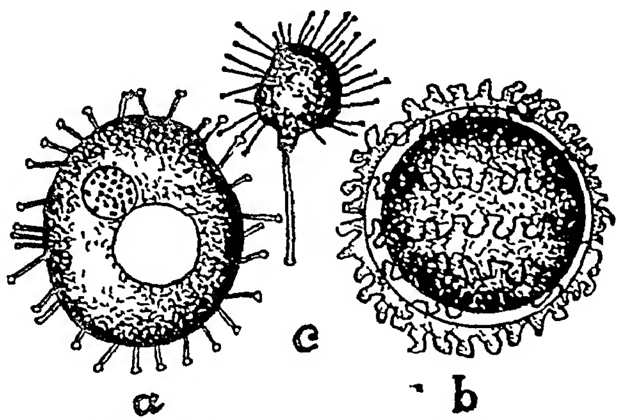


Fig 212—*Podophrya sandi* Collin *a*, stalkless stage, *b*, cyst, *c*, adult stalked stage *a* and *b* more highly magnified than *c* (After Sand)

one to three bundles Contractile vacuole eccentric Macronucleus central, spherical or oval The motile stage has a complete girdle of cilia, two bundles of drawn-out tentacles, and a spherical macronucleus Cysts are nonpedunculate

Remarks—Sand (1901) referred the form described by Simmons from Calcutta to *Podophrya gelatinosa* (Buck), but Collin (1912) considered it a distinct species which he named *P sandi*

Habitat—Pond water BENGAL, Calcutta

Genus SPHÆROPHRYA Claparède & Lachmann, 1859

Sphærophrya, Claparède & Lachmann, 1858–61, p 385, Mecznikow, 1864, pp 258–61, pl 7 A, Kent, 1880–2, p 808, Butschli, 1887–9, p 1926, Sand, 1901, p 226, Collin, 1912, pp 401–3, Schenichen, 1927, p 292, Reichenow, 1929, p 1217, Kudo, 1931, p 402, Calkins, 1933, p 524, Kahl, 1934, p 198

Animalcules without a lorica, usually more or less spherical in form, with distinctly capitate sucking-tentacles scattered irregularly throughout the periphery, freely movable, and never developing a fixed pedicle as in the genera *Podophrya* and *Acineta* Multiplication by equal or unequal division, and also through exogenous budding Free-living or parasitic on or within other animalcules

310 Sphærophrya pusilla Claparède & Lachmann (Figs 213 & 214)

Sphærophrya pusilla, Claparède & Lachmann, 1858–61, p 385, pl i, fig 11
Embryo of *Paramœcium bursarium*, Stein, 1859 *d*, p 99
Embryo of *Urostyla grandis*, Stein, 1859 *d*, p 103
Embryo of *Stylonichia mytilus*, Stein, 1859 *d*, p 103
†*Sphærophrya* sp, Carter, 1861
Sphærophrya sol, Mecznikow, 1864, p 261, fig 6
Sphærophrya stylonychiæ, Kent, 1880–2, p 810
Sphærophrya pusilla, Kent, 1880–2, p 808, pl xlvi, fig 6
Sphærophrya sol, Kent, 1880–2, p 810, pl xlvii, figs 6, 7
Sphærophrya parameciorum, Maupas, 1881, p 304
Sphærophrya urostylæ, Maupas, 1881, p 304, Kent, 1880–2, pp 809–10, pl xlvi figs 3–5
Sphærophrya, sp, Schewiakoff, 1893, p 151
Sphærophrya pusilla, Sand, 1901, pp 228–30, Collin, 1912, pp 402–3
†*Sphærophrya pusilla*, Bhatia, 1920, p 265
Sphærophrya sol, Schoenichen, 1927, p 292, fig 823, Reichenow, 1929, p 1217, fig 1201, p 391, fig 378
Sphærophrya pusilla, Wenyon, 1926, pp 1228–9, fig 534, Schoenichen, 1927, p 292, Kahl, 1934, p 198

Body minute, spherical, bearing a variable number of short, widely scattered knobbed tentacles Contractile vacuole single Macronucleus rounded or ovate Multiplication by transverse fission

Diameter —Diameter 12–15 μ

Free-living or parasitic within many HYPOTRICHA, *Paramecium*, *Nassula*, etc

Remarks —A specimen of *Paramecium caudatum* containing four young individuals of this species was encountered at Lahore Two of these individuals, provided with knobbed

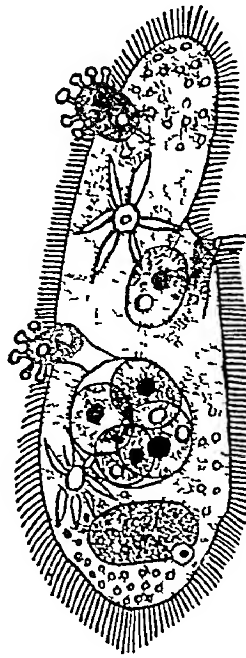


Fig 213 —*Sphærophrya pusilla* Clap & Lachm One embryo is making its way into the cytoplasm of *Paramecium caudatum* near its anterior end In the hinder part a vacuole contains four organisms, from an opening of which an embryo is escaping (From Reichenow, after Bütschli)

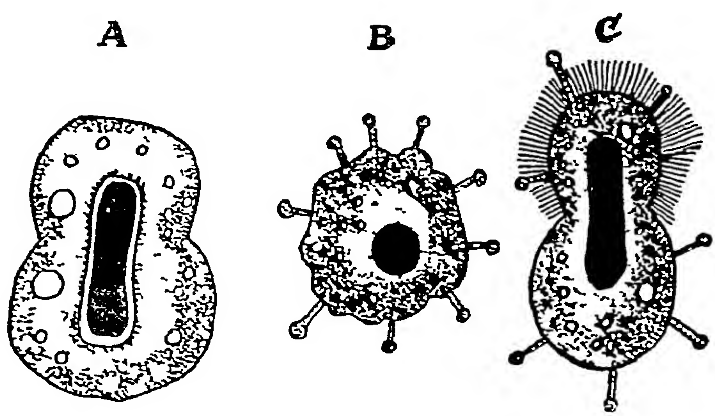


Fig 214 —*Sphærophrya pusilla* Clap & Lachm *A*, dividing stage, *B*, free living individual with tentacles, *C*, development of a free swimming embryo with tentacles and cilia (From Reichenow, after Bütschli)

tentacles all round, escaped under observation and began to swim freely The body of these individuals was very small Butschli (1887–9) identified the form occurring in *Paramecium* and described by Maupas as *Sphærophrya paramecìorum* with *Sphærophrya pusilla* Claparède & Lachmann Schoenichen (1927) and Reichenow (1929) consider the form occurring in *Paramecium*, *Nassula*, etc , as *Sphærophrya sol* Meczmkow Mecznikow's work is not available to me, but according to the brief abstract given in the 'Zoological Record' (1864) *S sol* Mecznikow was found in a marsh in a wood

Habitat—Endoparasite of *Paramecium caudatum* Ehrbg · PUNJAB, Lahore Fresh water PUNJAB, Hoshiarpur, Bombay

BIBLIOGRAPHY.

ABÉ, T (1928–9) —On the classification of *Balantidium* (Preliminary Report) (Abstract) *Japan J Zool*, II, p 89

†ALEXEIEFF, A (1912) —Sur quelques Protistes parasites intestinaux d'une tortue de Ceylan (*Nicoria trijuga*) *Zool Anz*, XL, pp 97–105

—— (1928) —Sur la question des mitrochondries et de l'appareil de Golgi chez les Protistes *Arch Protistenk*, LX, pp 268–86, pls vii & viii, 2 text-figs

†ANDERSON, H H (1889) —*Anoplophrya ælosomata*, a new ciliate Infusorian parasitic in the Alimentary Canal of *Æolosoma chlorostictum* *J Asiat Soc Bengal*, LVII, part II, pp 381–3

ANDRÉ, E (1914) —Recherches sur la faune pelagique du Leman et description de nouveaux genres d'Infusoires *Rev suisse Zool*, XXII, pp 179–93

—— (1915) —Contribution a l'Étude de la faune infusorienne de lac Majeur *Rev suisse Zool*, XXIII, pp 101–8

—— (1916) —Contribution a l'Étude de la faune infusorienne du Leman *Rev suisse Zool*, XXIV, pp 621–34

ANDREWS, E A (1921) —American Folliculinas taxonomic notes *Amer Nat*, LV, pp 347–67

—— (1923) —*Folliculina* case making, anatomy and transformation *J Morph*, XXXVIII, pp 207–78, 46 figs

ANIGSTEIN, L (1912) —Über zwei neue marine Ciliaten *Arch Protistenk*, XXIV, pp 127–41, pl x

—— (1913) —Über *Strombidium testaceum*, nov spec, eine marine, oligotriche Ciliate *Arch Protistenk*, XXXII, pp 79–110, pls i & ii, 6 text figs

†ANNANDALE, N (1907) —The fauna of brackish ponds at Port Canning, Lower Bengal *Rec Indian Mus* I, pt 1, pp 35–43

ARIAKE, B (1929) —Five new species of *Trichodina* *Annot zool jap*, XII, pp 285–8, 1 text fig (English abstr in *Japan J Zool*, III, p 68)

ATCHLEY F (1933) —The cultivation of the *Balantidium* of the chimpanzee in fecal extract *J Parasit*, XX, p 144

ATCHLEY, F O (1935) —The maintenance of a strain of *Balantidium* in laboratory rats *J Parasit*, XXI, pp 183–5

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† prefixed to a reference indicates that it records some species from India, Burma or Ceylon

AUNAP, E (1927) —Eine Methode, Infusorien auf dem Objekttrager zu fixieren und zu farben *Arch Protistenk*, LX, pp 193–6, 2 figs

AUSTIN, M L (1927) —Studies on *Uroleptus mobilis* —I An attempt to prolong the life cycle II The conditions necessary for conjugation, *J Exp Zool*, XLIX, pp 149–216, 9 figs

AWERINZEW, S, & MUTAFOWA, R (1914) —Material zur Kenntnis der Infusorien aus dem Magen der Wiederkäuer —I *Arch Protistenk*, XXXIII, pp 109–18, pls IX & X

AYNAUD, M (1932) —Parasitisme d'un infusoire dans les parois de la panse du mouton *C R Acad Sci Paris*, CXCV, pp 629–30

BALBIANI, E G (1860 *a*) —Observat et exper s les phénom de la reproduct fissipare chez les infusoires ciliies *C R Acad Sci Paris*, L, pp 1191–5

—— (1860 *b*) —Du rôle des organes générateurs dans la division spontanée des infusoires ciliées *J de la physiol*, III, pp 71–87, pls III & IV (also in *C R Acad Sci Paris*, XLVIII, (1859) pp 266–71)

—— (1861) —Recherches sur les phénomènes sexuelles des infusoires *J de la physiol*, IV, pp 102–30, 194–220, 431–48, 465–520, pls VII–IX

—— (1873) —Observations sur le *Didinium nasutum* *Arch Zool exp gen*, II, pp 363–94

—— (1885) —Sur un infusoire parasite du sang da l'Aselle aquatique (*Anoplophrya circulans*) *Recueil zoolog Suisse*, II, pp 277–303

—— (1887 *a*) —Observations relatives à une note récente de M Maupas s la multiplication de la *Leucophrys patula* *C R Acad Sci Paris*, CIV, pp 80–3

—— (1887 *b*) —Evolution des micro organisms animaux et vegétaux parasites *J Micrograph*, XI, pp 54–62, 134–42, 170–7, 196–205, 233–40, 365–73, 393–406, 434–46, 463–76, 499–511, 534–44

—— (1889) —*Ibid* (Suite) *J Micrograph*, XIII, pp 5–9

—— (1890 *a*) —Sur la structure intime du noyau du *Loxophyllum meleagris* *Zool Anz*, XIII Jahrg, No 329, pp 110–15, No 330, pp 132–6 *Arch Zool exp gén*, (2) VIII, pp xv & xvi

—— (1890 *b*) —Étude sur le Loxode *Ann Micrograph*, II, pp 401–31

—— (1890 *c*) —Recherches expérimentales sur la merotomie des Infusoires ciliés *Recueil zoolog Suisse*, V, pp 1–71

—— (1893) —Nouvelle recherches expérimentales sur la mérotomie des Infusoires ciliés *Ann Micrograph*, V, pp 1–25, 49–84, 113–37, 2 pls (Abstract in *J R Micr Soc*, 1893, pp 492–3)

BALL, G H (1925) —Studies on *Paramœcium* —I Experiments on the action of various endocrine substances, of liver and of glycogen on the division-rate of *Paramœcium* II The behaviour of a conjugating race of *Paramœcium caudatum* *Univ Calif Publ Zool*, XXVI, pp 353–433

—— (1927) Studies on *Paramecium* —III The effects of vital dyes on *Paramecium caudatum* *Biol Bull Wood's Hole*, LII, pp 68–78

Barret, H P, & Yarbrough, N (1921)—A method for the cultivation of *Balantidium coli* *Amer J Trop Med*, I, pp 161–4

Baumeister, W (1932)—Das Infusor *Tropidoatractus acuminatus* Levander *Arch Protistenk*, LXXVII, pp 360–78, 19 figs

Becker, E R (1932)—The present status of problems relating to the ciliates of ruminants and equidæ *Quart Rev Biol*, VII, pp 282–97, 2 figs

—— & Hsiung, T S (1929 *a*)—*Buxtonella sulcata* Jameson, 1926 (Protozoa, Ciliata) cysts and cyst formation *Parasitology*, XXI, pp 266–8, 7 figs

—— —— (1929 *b*)—The method by which ruminants acquire their fauna of infusoria and remarks concerning experiments on the host specificity of these protozoa *Proc Nat Acad Sci Wash*, XV, pp 684–90

——, Schulz, J A, & Emerson, M A (1930)—Experiments on the physiological relationships between the stomach infusoria of ruminants and their hosts, with a bibliography *Iowa State Coll J Sci*, IV, pp 215–51, 4 figs

—— & Talbot, M (1927)—The protozoan fauna of the rumen and reticulum of American cattle *Iowa State Coll J Sci*, I, pp 345–73, 3 pls

Beers, C D (1925)—Encystment and the life cycle in the ciliate *Didinium nasutum* *Proc Nat Acad Sci Wash*, XI, pp 523–8

—— (1926)—The life cycle in the ciliate *Didinium nasutum* with reference to encystment *J Morph*, XLII, pp 1–21, 2 figs

—— (1927 *a*)—Factors involved in encystment in the ciliate *Didinium nasutum* *J Morph*, XLIII, pp 499–520

—— (1927 *b*)—The relation between hydrogen ion concentration and encystment in *Didinium nasutum* *J Morph*, XLIV, pp 21–8

—— (1929)—On the possibility of indefinite reproduction in the ciliate *Didinium* without conjugation or endomixis *Amer Nat*, LXIII, pp 125–9

—— (1930)—Some effects of encystment in the ciliate *Didinium nasutum* *J Exp Zool*, LVI, pp 193–208

—— (1935)—Structural changes during encystment and excystment in the ciliate *Didinium nasutum* *Arch Protistenk*, LXXXIV, pp 133–55, 17 figs

Bělař, K (1928)—V Spezielle Mikrotechnik—I Untersuchung der Protozoen In Péterfi, T Methodik der Wissenschaftlichen Biologie, I, pp 735–826, 14 figs

Belehradek, J (1920)—Sur le mouvement des Vorticelles *C R Soc Biol Paris*, LXXXIII, pp 1362–3

Beltran, E (1925)—*Opalina hylaxena* forma *mexicana*, new forma from *Hyla* sp ? of Mexico *Trans Amer Micr Soc*, XLIV, pp 222–3, 1 fig

†Bezzenberger, E (1904)—Über Infusorien aus asiatischen Anuren *Arch Protistenk*, III, pp 138–74, pl xi & 23 text-figs

†Bhatia, B L (1916)—Notes on the Ciliate Protozoa of Lahore *Rec Indian Mus*, XII, pt 5, pp 177–83, 3 figs

†—— (1920)—Notes on fresh-water ciliate protozoa of India *J R Micr Soc*, pp 257–67

†—— (1922) Do—II *J R Micr Soc*, pp 27–36

†—— (1923)—On the significance of extra contractile vacuoles in *Paramœcium caudatum* *J R Micr Soc*, pp 69–72

†BHATIA, B L (1935)—Gaps in our knowledge of the Indian Protozoa—I Ciliophora *Curr Sci*, IV, pp 13–16

†—— & GULATI, A N (1927)—On some parasitic ciliates from Indian frogs, toads, earthworms and cockroaches *Arch Protistenk*, LVII, pp 85–120, 12 figs

†—— & MULLICK, B K (1930)—On some fresh-water ciliates from Kashmir *Arch Protistenk*, LXXII, pp 390–403, 3 figs

BIGGAR, R B, & WENRICH, D H (1932)—Studies on ciliates from Bermuda sea urchins *J Parasit*, XVIII, pp 252–7, 1 pl

BISHOP, A (1923)—Some observations upon *Spirostomum ambiguum* (Ehrenberg) *Quart J Micr Sci*, LXVII, pp 391–434, pls xxii–xxiii

—— (1925)—A study of the micronuclei of *Spirostomum ambiguum major* during division *Quart J Micr Sci*, LXIX, pp 661–9, pls li & lii

—— (1926)—Notes upon *Sieboldiellina planariarum* (Siebold), a ciliate parasite of *Planaria torva* *Parasitology*, XVIII, pp 187–94, pl viii, 5 text figs

—— (1927)—The cytoplasmic structures of *Spirostomum ambiguum* Ehrenberg *Quart J Micr Sci*, LXXI, pp 147–72, pls xvii–xviii, 3 text figs

BLATTNER, H (1926)—Beiträge zur Reizphysiologie von *Spirostomum ambiguum* Ehrenberg *Arch Protistenk*, LIII, pp 253–311, 25 figs

BLOCHMANN, F (1895)—Die mikroskopische Thierwelt d Susswassers Braunschweig

—— & KIRCHNER (1905)—Die mikrokopische Tier- und Pflanzenwelt des Susswassers 2 Aufl Teil I

BODINE, J H (1923)—Excystation of *Colpoda cucullus* Some factors affecting excystation of *Colpoda cucullus* from its resting cysts *J Exp Zool*, XXXVII, pp 115–25

BOGDANOWICZ, A (1930)—Über die Konjugation von *Loxodes striatus* und *Loxodes rostrum* *Zool Anz*, LXXXVII, pp 209–22, 8 figs

BOJEWA-PETRUSCHEWSKAJA, T P (1933)—Zum Entwicklungszyklus von *Nyctotherus cordiformis* (In Russian, with German summary) *Trav Soc Nat (Leningrad)* (Sect Zool), LXII, pp 341–5

BORY DE SAINT VINCENT, (1822–31)—Dictionnaire classique d'Histoire naturelle, I–XVII Paris

—— (1824)—Histoire naturelle des zoophytes, faisant suite à l'histoire naturelle de vers de Bruguièra T II Paris

BOURNE, G C (1922)—An Introduction to the study of the Comparative Anatomy of Animals London

BOZLER, E (1924)—Über die Morphologie der Ernahrungsorganelle und die Physiologie der Nahrungsaufnahme bei *Paramæcium caudatum* Ehrb *Arch Protistenk*, XLIX, pp 163–215, pl viii, 10 text-figs

v BRAND, TH (1923)—Die Encystierung bei *Vorticella microstoma* und hypotrichen Infusorien *Arch Protistenk*, XLVII, pp 59–100, pls v–vii

BRAUNE, R (1913)—Untersuchungen über die im Wiederkäuermagen vorkommenden Protozoen *Arch Protistenk*, XXXII, pp 111–70, pls iii–vi

BRESSLAU, E (1919) —*Stylis hoffi* n gen n sp, eine neu Vorticellide *Biol Zbl*, XXXIX, pp 41–59

—— (1922) —Zur Systematik der Ciliatengattung *Colpidium* *Zool. Anz*, LV, pp 21–28

BRETSCHNEIDER, L H (1934) —Beiträge zur Struckturlehre der Ophryoscoleciden —II *Arch Protistenk*, LXXXII, pp 298–330, 26 figs

BRUMPT, E (1909) —Démonstration du rôle pathogene du *Balantidium coli* Enkystment et conjugaison de cet Infusoire *C R Soc Biol Paris*, LXVII, pp 103–5

—— (1922) —Précis de Parasitologie Third edition Paris

v BUDDENBROCK, W (1920) —Beobachtungen uber einige neue oder wening bekannte marine Infusorien *Arch Protistenk*, XLI, pp 341–64, pls xvi & xvii

—— (1922) —Über eine neue *Strombidium*-Art aus Helgoland (*Str clavellinæ*) *Arch Protistenk*, XLV, pp 129–32, 3 figs

BUCK, E (1884) —Ueber die ungestielte Varietät der *Podophrya fixa* (*P libra*, Pty) *Ber senckenb naturf Ges*, pp 298–314, figs

BUISSON, J (1923 *a*) —Sur quelques Infusoires nouveaux ou peu connus parasites des mammifères *Ann Parasitol Paris*, I, pp 209–46, 21 figs

—— (1923 *b*) —Les Infusoires ciliés du tube digestif de l'homme et des mammifères *Trav Lab Parasitol Faculte de Medecine, Paris*, pp 1–201, 60 figs

BULLINGTON, W E (1925) —A Study of Spiral Movement in the Ciliate Infusoria *Arch Protistenk*, L, pp 219–74, 9 figs

BUSCH, W (1920) —*Quasillagilis*, ein neues Ciliatengenus aus dem Schwarzen Meer *Arch Protistenk*, XL, pp 221–9, pls xvii & xviii

—— (1921) —Studien uber Ciliaten des Nordatlantischen Ozeans und Schwarzen Meeres —I *Arch Protistenk*, XLII, pp 364–79, pls xvi & xvii

—— (1923) —Studien über Ciliaten des Nordatlantischen Ozeans —II *Arch Protistenk*, XLVI, pp 203–10, 4 figs

—— (1924) —*Strombidium mucotectum* nov spec *Arch Protistenk*, L, pp 135–8, 2 figs

—— (1926) —Beitrag zur Kenntnis der Gehäusbildung bei den Tintinnidæ und zur Kenntnis mariner Ciliaten *Arch Protistenk*, LIII, pp 183–90, 9 figs

BUSCHKIEL, A L (1911) —Beiträge zur Kenntnis des *Ichthyophthirius multifilis* Fouquet *Arch Protistenk*, XXI, pp 61–102, pls iv & v, 1 text-fig

BUSH, M (1933) —The morphology of the ciliate *Haptophyra michiganensis* Woodhead and its relation to the other members of the Astomatea *Trans Amer Micr Soc*, LII, pp 223–32, 2 figs

—— (1934) —The morphology of *Haptophrya michiganensis* Woodhead, an astomatous ciliate from the intestinal tract of *Hemidactylium scutatum* (Schlegel) *Univ Calif Publ Zool*, XXXIX, (12) pp 251–76, 3 pls, 2 text figs.

BUTSCHLI, O (1873) —Einiges über Infusorien *Arch mikr Anat*, IX, pp 657–78

BÜTSCHLI, O (1876)—Studien über die ersten Entwickelungsvorgänge der Eizelle, die Zelltheilung, und die Conjugation der Infusorien *Abh senckenb naturf Ges*, X, pp 213–464, pls i–xv

—— (1887–9)—Protozoa (Bronn's Klassen und Ordnungen des Thier Reichs), Bd III Leipzig pp 1098–280 (1887), pp 1281–584 (1888), pp 1585–2035 (1889)

—— (1889)—Über zwei interessante Ciliatenformen (*Hastatella* n g *radians* n sp *Actinobolus radians*) Tagebl der 62 Versamml deutsch Naturf und Aerzte zu Heidelberg, pp 265–6

CALDWELL, L (1933)—The production of inherited diversities at endomixis in *Paramecium aurelia* *J Exp Zool*, LXVI, pp 371–407, 1 fig

CALKINS, G N (1901)—The Protozoa New York Pp 1–347

—— (1917)—*Didinium nasutum*—I The Life history *J Exp Zool*, XIX, pp 225–41, 1 pl

—— (1919 *a*)—*Uroleptus mobilis* Engelm—I History of the nuclei during division and conjugation *J Exp Zool*, XXVII, pp 273–357

—— (1919 *b*)—*Uroleptus mobilis* Engelm—II Renewal of vitality through conjugation *J Exp Zool*, XXIX, pp 121–56

—— (1920)—*Uroleptus mobilis* Engelm—III A study in Vitality *J Exp Zool*, XXXI, pp 287–305

—— (1921)—*Uroleptus mobilis* Engelm—IV Effect of cutting during conjugation *J Exp Zool*, XXXIV, pp 449–70, 10 figs

—— (1923)—What did Maupas mean? *Amer Nat*, LVII, pp 350–70

—— (1925)—*Uroleptus mobilis*—V The history of a double organism *J Exp Zool*, XLI, pp 191–213

—— (1926)—The Biology of the Protozoa New York Pp 1–623

—— (1929)—*Uroleptus halseyi*, n sp—I The effect of ultra-violet rays *Biol Bull Wood's Hole*, LVII, pp 59–68, 6 figs

—— (1930 *a*)—*Uroleptus halseyi* Calkins—II The origin and fate of the macronuclear chromatin *Arch Protistenk*, LXIX, pp 151–74, 2 pls, 1 text-fig

—— (1930 *b*)—*Uroleptus halseyi* Calkins—III The kinetic elements and the micronucleus *Arch Protistenk*, LXXII, pp 49–70, 4 pls, 4 text figs

—— (1933)—The Biology of the Protozoa 2nd edition London Pp xi+607, 223 text figs, 2 pls

—— & BOWLING, R (1928)—Studies on *Dallasia frontata* Stokes—I Polymorphism *Biol Bull Wood's Hole*, LV, pp 101–12, 3 figs

—— —— (1929)—Studies on *Dallasia frontata* Stokes—II Cytology, gametogamy and conjugation *Arch Protistenk*, LXVI, pp 11–32, 19 figs

—— & CULL, S W (1907)—The Conjugation of *Paramæcium aurelia* (*caudatum*) *Arch Protistenk*, X, pp 375–415, pls xii–xviii

CAMPBELL, A S (1929)—The structure of *Isotricha prostoma* *Arch Protistenk*, LXVI, pp 331–39, 3 pls

—— (1930)—Fission in *Isotricha prostoma*—*Arch Protistenk*, LXXII, pp 141–6, 2 pls

CARINI, A (1933 *a*) —Sur une nouvelle *Zellerıella* (*Z falcata* n sp) de l'ıntestın d'une grenouılle *Ann Parasıtol Parıs*, XI, pp 115–16, 1 fig

—— (1933 *b*) —Sur une nouvelle *Zellerıella*, *Z cornucopıa* n sp , du *Leptodactylus ocellatus* *Ann Parasıtol Parıs*, XI, pp 301–2, 1 fig

—— (1933 *c*) —*Zellerıella boıpevæ* n sp , parasıte de l'ıntestın d'un serpent *C R Soc Bıol Parıs*, CXII, pp 400–1, 1 fig

—— (1933 *d*) —Sur une nouvelle Zellerıelle (*Z jaegerı*) de l'ıntestın d'un serpent *C R Soc Bıol Parıs*, CXII, pp 1001–2, 1 fig

—— (1933 *e*) —Sobre alguns *Nyctotherus* do ıntestıno de cobras do Brasıl (In Portuguese) *Rev Bıol Hyg S Paulo*, IV, pp 7–9, 4 figs

—— (1933 *f*) —Sobre un *Nyctotherus* do ıntestıno de um coleoptero (In Portuguese) *Rev Bıol Hyg S Paulo*, IV, pp 9–10, 1 fig

†CARTER, H J (1855) —Further observatıons on the Development of Gonıdıa etc *Ann Mag Nat Hıst* , (2) XVI, pp 1–22

†—— (1856 *a*) —Do —*Ann Mag Nat Hıst* , (2) XVII, pp 101–27

†—— (1856 *b*) —Notes on the fresh-water Infusorıa of the Island of Bombay *Ann Mag Nat Hıst* , (2) XVIII, pp 115–32, 221–49

†—— (1857 *a*) —On the ultımate structure of Spongılla and addıtıonal notes on fresh water Infusorıa *Ann Mag Nat Hıst* , (2) XX, pp 21–41

†—— (1857 *b*) —Notes on fresh-water Infusorıa ın the Island of Bombay *J Bombay Br R Asıat Soc* , V, pp 429–67 574–97

†—— (1861) —Notes and correctıons on the organısatıon of Infusorıa, etc *Ann Mag Nat Hıst* , (3), VIII, pp 281–90

†—— (1865) —On the fresh- and salt water Rhızopoda cf England and Indıa *Ann Mag Nat Hıst* , (3) XV, pp 277–93

†—— (1869) —Notes on the fılıgerous green Infusorıa of the Island of Bombay *Ann Mag Nat Hıst* , (4) III, pp 249–60

CASTELLANI, A , & CHALMERS, A J (1919) —Manual of Tropıcal Medıcıne, 3rd ed London Pp 344–351

CAUSEY, D (1926) —Mıtochondrıa ın cılıates, wıth specıal reference to *Paramecıum caudatum* Ehr *Unıv Calıf Publ Zool* , XXVIII pp 231–50, pls xxıı–xxıv

CAUSIN, M (1931) —La régeneratıon du *Stentor cœruleus* *Arch Anat mıcr* , XXVII, pp 107–25, 13 figs

CAVALLINI, F (1931) —La gemmazıone ın *Trıchodına pedıculus* *Arch Protıstenk* , LXXV, pp 167–78

CÉPÈDE, C (1910) —Recherches sur les Infusoıres astomes *Arch Zool exp gén* , (5) III, pp 341–609, pls ıx–xvıı

—— (1923) —Note taxonomıque sur les ınfusoıres astomes (Haptophryıdæ Cépède nom nov pro Dıscophryıdæ Cépède 1910) *Bull Soc zool Fr* , XLVIII, p 105

CERTES, A (1879) —Note sur l'*Haptophrya gıgantea* Maupas, etc *Bull Soc zool Fr* , IV, pp 240–4

—— (1882) —Sur les parasıtes ıntestınaux de l'huıtre *Bull Soc zool Fr* , VII, pp 347–53

—— (1891) —Note sur deux Infusoıres nouveaux des envırons de Parıs (*Conchophthırıus Metschnıkoffi* et *Odontochlamys Gouraudı*) *Mém Soc zool Fr* , IV, pp 536–41, pl vıı

†CHAKRAVARTI, M M (1933)—Boring apparatus in *Balantidium* *Curr Sci*, I, pp 345–6, figs 1–3

CHAMBERS, R, & DAWSON, J A (1925)—The structure of the undulating membrane in the Ciliate *Blepharisma* *Biol Bull Wood's Hole*, XLVIII, pp 240–2

†CHATTERJEE, B K (1928)—A case of balantidial dysentery *Indian Med Gaz*, LXIII, p 79

CHATTON, E (1910)—Protozoaires parasites des branchies des Labres, *Amœba mucicola* Chatton, *Trichodina labrorum*, n sp Appendice parasite des Trichodines *Arch Zool exp gén*, (5) V, pp 239–266, pl iii

—— & BRACHON, S (1933)—Sur une paramécie a deux races *Paramœcium duboscqui* sp n *C R Soc Biol Paris*, CXIV, pp 988–91, 5 figs

—— & CHATTON, M (1927)—Sur les conditions nécessaires pour déterminer expérimentalement la conjugaison de l'Infusoire *Glaucoma scintillans* *C R Acad Sci Paris*, CLXXXV, pp 400–2

—— (1929 *a*)—Les conditions de la conjugaison du *Glaucoma scintillans* en cultures létho bacteriennes Action directe et spécifique de certain agents zygogènes *C R Acad Sci Paris*, CLXXXVIII, pp 1315–17

—— (1929 *b*)—L'état de jeune, condition nécessaire, maus non suffisante de la conjugaison expérimentale de l'infusoire *Glaucoma scintillans* *C R Acad Sci Paris*, CLXXXIX, pp 59–62

—— (1931)—La conjugaison du *Paramœcium caudatum* determiné expérimentalement par modification de la flore bactérienne associé Races dites conjugantes et non conjugantes *C R Acad Sci Paris*, CXCIII, pp 206–8

—— & COLLIN, B (1910)—Sur un Acinétien nouveau commensal d'un Copépode, *Rhabdophrya trimorpha*, n g, n sp *Arch Zool exp gen*, (5) V, pp cxxxviii–cxlv

—— & LWOFF, A (1921)—Sur une famille nouvelle d'Acinétiens, les *Sphenophryidæ*, adaptés aux branchies des mollusques acéphales *C R Acad Sci Paris*, CLXXIII, pp 1495–7

—— —— (1922–4)—Sur l'evolution des infusoires des Lamellibranches *C R Acad Sci Paris*, CLXXV, pp 787–90, 915–17, 1444–7, 3 figs, CLXXVII, p 81, CLXXVIII, pp 1928–30

—— —— (1924)—Sur un Infusoire marin astome *Spirophrya subparasitica* n g, n sp *C R Acad Sci Paris*, CLXXVIII, pp 1642–4

—— —— (1925 *a*)—L'ethologie et la structure des *Spirophrya* Leur parenté avec les *Fœttingeria* L'origine et l'evolution du parasitisme de ces Infusoires *C R Acad Sci Paris*, CLXXX, pp 229–32

—— —— (1925 *b*)—Sur le déterminisme physiologique des phases du cycle de l'Infusoire *Spirophrya subparasitica* Ch et Lw *C R Acad Sci Paris*, CLXXX, pp 338–40

—— —— (1926 *a*)—La structure et le cycle évolutif des Infusoires des mues de Crustacés et leur place parmi les Fœttingeriidæ *C R Acad Sci Paris*, CLXXXII, pp 100–2

CHATTON, E, & LWOFF, A (1926 *b*)—Les *Synophrya*, Infusoires parasites internes des Crabes Leur évolution a la mue Leur place parmi les Fœttingeridæ *C R Acad Sci Paris*, CLXXXIII, pp 1131–4

—— —— (1926 *c*)—Diagnoses de ciliés thigmotriches nouveaux *Bull Soc zool Fr*, LI, pp 345–52

—— —— (1927 *a*)—Le cycle évolutif de l'infusoire *Fœttingeria actiniarum* Nécessité d'un second hôte crustacé *C R Acad Sci Paris*, CLXXXV, pp 675–7

—— —— (1927 *b*)—Le cycle évolutif de la *Synophrya hypertrophica* (cilié Fœttingeridæ) *C R Acad Sci Paris*, CLXXXV, pp 877–9

—— —— (1927 *c*)—Les métamorphoses des Fœttingeridæ (Ciliés) et les transformations de leur ciliature au cours du cycle évolutif *C R Acad Sci Paris*, CLXXXV, pp 1075–8 6 figs

—— —— (1928)—Sur la structure, l'évolution et les affinites des Opalinopsides (Ciliés) des Cephalopodes *C R Acad Sci Paris*, CLXXXVI, pp 1382–4

—— —— (1934 *a*)—Sur un cilié thigmotriche nouveau *Gargarius gargarius* n gen, n sp, de *Mytilus edulis* *Bull Soc zool Fr*, LIX, pp 375–6

—— —— (1934 *b*)—Sur un infusoire parasite des poils sécréteurs des crustacés Edriophtalmes et la famille nouvelle des Pilisuctoridæ *C R Acad Sci Paris*, CIC, pp 696–9, 1 fig

——, LWOFF, M, & LWOFF, A (1929)—Les metamorphoses prépalintomiques et métapalantomiques des Fœttingeridæ (Ciliés) *C R Acad Sci Paris*, CLXXXVIII, pp 273–5

—— —— —— (1930 *a*)—Les *Phtorophrya* n g, cilies Fœttingeridæ, hyperparasites des Gymnodinioides, Fœttingeridæ parasites des crustacés *C R Acad Sci Paris*, CXC, pp 1080–2

—— —— —— (1930 *b*)—*Phoretophrya nebaliæ*, n g, n sp, et l'interprétation du cycle évolutif des Ciliés Fœttingerides *C R Acad Sci Paris*, pp 1152–4

†CHAUDHURI, H (1929)—A study of the protozoal content of certain soils of India *Ann Protistologie Paris*, II, pp 41–60, pls i–iv

CHAVARRIA, M (1933 *a*)—Estudios protistologicos—I Fauna del tubo digestivo del toro (*Bos taurus* Linn) de Mexico *An Inst Biol Univ Méx*, IV, pp 109–42, 28 figs

—— (1933 *b*)—*Ochoterenaia appendiculata* gen n, sp n, nuevo infusorio del intestino del caballo (*Equus caballus* Linn) de Mexico *An Inst Biol Univ Méx*, IV, pp 191–6, 6 figs

CHEISSEN, E (1930)—Morphologische und systematische Studien über Astomata aus dem Baikalsee *Arch Protistenk*, LXX, pp 531–618, 5 pls, 14 text-figs

—— (1931)—Infusorien *Ancistridæ* und *Boveridæ* aus dem Baikalsee *Arch Protistenk*, LXXIII, pp 280–304, 1 pl, 10 text-figs

CHEJFEE, M (1930)—Zur Kenntnis der Kernreorganisations prozesse bei *Paramæcium caudatum* *Arch Protistenk*, LXX, pp 87–118, 3 figs

CHEN, L (1933)—Züchtungsversuche an parasitischen Protozoen von *Periplaneta orientalis* (*Endamœba blattæ*, *Nyctotherus ovalis*, *Lophomonas blattarum*) *Z Parasitenk*, VI, pp 207–19

CLAPARÈDE & LACHMANN, (1858–61)—Études sur les infusoires et les rhizopodes, Genève (Extrait des toms V, VI, et VII des Mémoires de l'Institut Genevois)

CODREANU, R (1930) —Sur la phase interne du cycle évolutif de deux formes d'*Ophryoglena*, infusoires endoparasites des larves d'Ephémères *C R Acad Sci Paris*, CXC, pp 1154–7

—— (1934) —La présence d'*Ophryoglena*, ciliés endoparasites chez les nymphes de l'ephémère *Oligoneura rhenana* Imhoff en France *Ann Protistologie Paris*, IV, pp 181–3

COHN, F (1851) —Beiträge zur Entwicklungsgeschichte der Infusorien *Z wiss Zool*, III, pp 257–79

—— (1853) —Beiträge zur Entwicklungsgeschichte der Infusorien *Z wiss Zool*, IV, pp 253–81, pl xiii

—— (1854 *a*) —Ueber Encystirung v *Amphileptus fasciola* *Z wiss Zool*, V, p 434–5

—— (1854 *b*) —Beiträge zur Kenntniss der Infusorien —III Über die Cuticula der Infusorien *Z wiss Zool*, V, pp 420–9

—— (1857) —Ueber Fortpflanzung von *Nassula elegans* *Z wiss Zool*, IX, pp 143–6

—— (1866) —Neue Infusorien in Seeaquarium *Z wiss Zool*, XVI, pp 253–302

COHN, L (1904) —Zwei Parasitische Infusorien aus *Discoglossus pictus* *Arch Protistenk* IV, pp 42–63, pl iv

COLE, F J (1926) —The History of Protozoology Pp 1–64

COLLIN, B (1909 *a*) —La conjugaison d'*Anoplophrya branchiarum* (Stein) *Arch Zool exp gén*, (5) I, pp 345–88, pls vii & viii

—— (1909 *b*) —Sur l'existence de la conjugaison gemmiforme chez les Acinétiens *C R Acad Sci Paris*, CXLVIII, pp 1416–18

—— (1909 *c*) —Diagnoses préliminaires d'Acinétiens nouveaux ou mal connus *C R Acad Sci Paris*, pp 1094–5

—— (1909 *d*) —Quelques remarques sur deux Acinétiens *C R Acad Sci Paris*, pp 1407–8

—— (1909 *e*) —Sur deux formes nouvelles d'Infusoires Discotriches *Arch Zool exp gén*, (5) ii, pp xxi–xxix

—— (1911 *a*) —Sur la conjugaison des Infusoires Astomes *Arch Zool exp gén*, (5) VIII, pp xx–xxviii

—— (1911 *b*) —Étude monographique sur les Acinetiens *Arch Zool exp gén*, (5) VIII, pp 421–97, pls x & xi

—— (1912) —Étude monographique sur les Acinetiens —II *Arch Zool exp gen*, LI, pp 1–457, pls i–vi & 111 text-figs

—— (1913) —Sur en ensemble de Protistes Parasites des Batraciens (Note Préliminaire) *Arch Zool exp gén*, LI, pp 59–76

—— (1914 *a*) —Notes protistologiques *Arch Zool exp gén*, LIV, (Notes et Revue) pp 85–97

—— (1914 *b*) —Sur les formes d'involution d'un Infusoire cilié dans le rein d'un Céphalopode *C R Acad Sci Paris*, CLVIII, pp 891–2

CONKLIN, C (1930) —*Anoplophrya marylendensis* n sp, a ciliate from the intestine of earthworms of the family *Lumbricidæ* *Biol Bull Wood's Hole*, LVIII, pp 176–81, 1 pl

CONN, H W, & EDMONDSON, C H (1918) —Flagellate and Ciliate Protozoa, in Ward and Whipple's Fresh water Biology New York

†COOPER, H, & GULATI, A N (1926) —On the occurrence of *Isospora* and *Balantidium* in cattle *Mem Depart Agric India, Vet*, III, pp 191–3

CORDERO, E H (1918)—Estudios sobre Algunos Protozoarios Ciliados de las Aquas Dulces del Uruguay Montevideo Pp 1–77, 4 pls

—— (1919)—" Opalina Antilliensis " Metcalf, ciliado parasite de los Batracios del Uraguay *Physis B Aires*, IV, pp 531–5

CRAIG, C F (1926)—Parasitic Protozoa of Man Philadelphia Ciliates, pp 517–34, figs 89–95

CRAWLEY, H (1923)—Evolution in the Ciliate family Ophryoscolecidæ *Proc Acad Nat Sci Philad*, LXXV, pp 393–412, pls xxviii & xxix

DA CUNHA, A M (1914)—Ueber die Ciliaten, welche in Brasilien im Magen von Rindern und Schafen vorkommen *Mem Inst Oswaldo Cruz*, VI, pp 58–68, pl vii

—— & PENIDO, J C N (1926)—Nouveau protozoaire parasite des poissons *Zelleriella piscicola* n sp *C R Soc Biol Paris*, XCV, pp 1003–5, 6 figs

—— & PINTO, C (1927)—*Nyctotherus travassosi* n sp, cilié parasite d'Oligochete du Bresil *C R Soc Biol Paris*, XCVII, pp 817–19, 2 figs

†DADAY, E v (1898)—Mikroskopische süsswasserthiere aus Ceylon *Természetro Füz*, Anhang zu XXI, pp 1–123 (Protozoa portion, pp 2–9 only)

DAIN, L (1930)—Die Conjugation von *Cryptochilum echini* Maupas *Arch Protistenk*, LXX, pp 192–216, 2 pls, 23 text figs

DARBY, H H (1929)—The effect of the hydrogen ion concentration on the sequence of protozoan forms *Arch Protistenk*, LXV, pp 1–37, 16 figs

†DAS GUPTA, M (1935)—Preliminary observations on the Protozoan fauna of the rumen of the Indian goat, *Capra hircus* Linn *Arch Protistenk*, LXXXV, pp 153–72, 6 figs

DAWSON, J A (1919)—An experimental study of an amicronucleate *Oxytricha*—I Study of the normal animal, with an account of cannibalism *J Exp Zool*, XXIX, pp 473–513, 2 pls

—— (1920)—An experimental study of an amicrouncleate *Oxytricha*—II The formation of double animals or " twins " *J Exp Zool*, XXX, pp 129–56, 1 pl

—— (1926 *a*)—A mutation in *Paramecium aurelia* *J Exp Zool*, XLIV, pp 133–56, 1 pl, 13 text figs

—— (1926 *b*)—The life-" cycle " of *Histrio complanatus* *J Exp Zool*, XLVI, pp 345–53

—— (1928)—A comparison of the life " cycles " of certain ciliates *J Exp Zool*, LI, pp 199 208, 2 figs

DEHORNE, A (1920)—Contribution à l'etude comparée de l'appareil nucléaire des Infusoires ciliés (*Paramœcium caudatum* et *Colpidium truncatum*), des Euglènes et des Cyanophycées *Arch Zool exp gén*, LX, pp 47–176, pls i–iv

—— (1927)—Sur un cilié parasite du *Clitello arenarius* Muller Ses relations avec l'*Opalina* (*Anoplophrya*) *filum* da Clap rede *C R Acad Sci Paris*, CLXXXV, pp 1219–21

DELAGE, Y, & HÉROUARD, E (1896)—Traité de Zoologie concrète—I La Cellule et les Protozoaires Paris Pp 1–584

DELPHY, J (1925)—Sur la fixation et la contractibilité de quelques Infusoires heterotriches *C R Acad Sci Paris*, CLXXX, pp 1058–61

—— (1927)—Sur la constitution de l'appareil nucléaire chez les infusoires les *Anoplophryimorphes* *C R Acad Sci Paris*, CLXXXV, pp 1323–25

DEMBOWSKI, J (1923)—Über die Bewegungen von *Paramæcium caudatum* *Arch Protistenk*, XLVII, pp 25–54, pls ii–iv, 3 text figs

DICKSON, H H (1920)—Contractile vacuoles *Nature*, CVI, pp 343, 441

DIERKS, K (1926)—Untersuchungen uber die Morphologie und Physiologie des *Stentor cœruleus* mit besonderer Berucksichtigung seiner kontraktilen und konduktilen Elemente *Arch Protistenk*, LIV, pp 1–91, pls i–iv, 28 text-figs

DIESING, K M (1865)—Revision der Protohelminthen Abtheilung Mastigophoren *Sitz Ber Akad Wiss Wien*, LII, pp 287–401

—— (1866)—*Ibid* Abtheilung Amastigen *Sitz Ber Akad Wiss Wien*, LII, pp 505–79, LIII, pp 49–144

DILLER, W F (1928)—Binary fission and endomixis in the *Trichodina* from tadpoles *J Morph*, XLVI, pp 521–61, pls i–iv, 1 text-fig

DIMITROWA, A (1928)—Untersuchungen uber die überzähligen pulsierenden Vakuolen bei *Paramæcium caudatum* Ehrbg *Arch Protistenk*, LXIV, pp 462–78, 22 figs

—— (1930)—Zur Frage der Teilungsgeschwindigkeit bei *Paramæcium caudatum* Ehrbg *Arch Protistenk*, LXXII, pp 554–8

DOBELL, C C (1909)—Some observations on the Infusoria parasitic in Cephalopoda *Quart J Micr Sci*, LIII, pp 183–99, pl i

†—— (1910)—On some parasitic Protozoa from Ceylon *Spolia Zeylan*, VII, pt xxvi, pp 65–87, pl ii

—— & O'CONNOR, F W (1921)—The Intestinal Protozoa of Man London Pp 1–211, 8 pls

DOBELL, C, & LOW, G C (1922)—Balantidiosis In Byam & Archibald's Practice of Medicine, London, II, pp 1671–5, fig 576

DOFLEIN, F (1901)—Die Protozoen als Parasiten und Krankheitserreger nach biologischen Gesichtspunkten dargestellt Jena Pp xiii+274, 220 figs

—— (1916)—Lehrbuch der Protozoenkunde Jena Vierte Auflage

—— & REICHENOW, E (1928–9)—Do Funfte Auflage, pp 1–1262

DOGIEL, V A (1922)—Die Artbildung in der Infusorien Familie Ophryoscolecidæ *Arch russes Protist*, II, pp 89–104

—— (1925 *a*)—Nouveaux Infusoires des famille des Ophryoscolecidés parasites d'antilopes africaines *Ann Parasitol Paris*, pp 116–42, 8 figs

—— (1925 *b*)—Die Geschlechtsprozesse bei Infusorien (speziell bei den Ophryoscoleciden) Neue Tatsachen und theoretische Erwagungen *Arch Protistenk*, L, pp 283–442, pls xii–xviii, 64 text figs, 1 Schema

—— (1925 *c*)—On the influence of the macronucleus on the formation of new morphological characters in Infusoria *Quart J Micr Sci*, LXIX, pp 611–17

DOGIEL, V. A (1925 *d*)—Neue parasitische Infusorien aus dem Magen des Renntieres (*Rangifera tarandus*) *Arch russes Protist*, IV, pp 43–65, pl ii, 12 text-figs

—— (1926)—Une nouvelle espèce du genre *Blepharocorys*, *B bovis* n sp habitant l'estomac du bœuf *Ann Parasitol Paris*, IV, pp 61–4, 1 fig

—— (1926 *a*)—Sur quelques infusoires nouveaux habitant l'estomac du dromadaire (*Camelus dromadarius*) *Ann Parasitol. Paris*, IV, pp 241–71, 10 figs

—— (1927)—Monographie der Familie Ophryoscolecidæ Teil 1. *Arch Protistenk*, LIX, pp 1–288, 134 figs

—— (1928 *a*)—Über die Conjugation von *Butschlia parva* *Arch. Protistenk*, LXII, pp 80–95, 25 figs

—— (1928 *b*)—La faune d'infusoires habitant l'estomac du buffle et du dromadaire *Ann Parasitol Paris*, VI, pp 328–38, 5 figs.

—— (1929)—Die sog "Konkrementvacuole" der Infusorien als eine Statocyste betrachtet *Arch Protistenk*, LXVIII, pp 319–48, 27 figs

—— (1932)—Beschreibung einiger neuer Vertreter der Familie Ophryoscolecidæ aus afrikanischer Antilopen nebst Revision der Infusorienfauna afrikanischer Wiederkauer *Arch Protistenk*, LXXVII, pp 92–107, 5 figs

—— (1934)—Angaben über die Ophryoscolecidæ des Wildschafes aus Kamtschatka, des Elches und des Yaks, nebst deren zoogeographischen Verwertung *Arch Protistenk*, LXXXII, pp 290–7

—— & FEDOROWA, T (1925)—Ueber den Bau und die Funktion des inneren Skeletts der Ophryoscoleciden *Zool Anz*, LXII, pp 97–107

—— & FEDOROVA-VINOGRADOVA, T (1930)—Experimental studies on the biology of infusoria from the stomach of ruminants (Russian, with English summary.) *Bull Inst Agric Microbiol, Leningrad*, IV, pp 157–87

DONS, C (1912)—*Folliculina* Studien, I–III—I *Folliculina spirorbis* n sp II Folliculinen aus Canale die Corsia (bei der Insel Cherso, nordl Adria) III Folliculinen, neu für die Fauna Norwegens *Arch Protistenk*, XXVII, pp 73–93, pl v, 6 text-figs

DUJARDIN, F (1841)—Histoire nat des zoophytes infusoires, 22 plates

DUNIHUE, F W (1931)—The vacuome and the neutral red reaction in *Paramæcium caudatum* *Arch Protistenk*, LXXV, pp 476–97, 7 figs

EBERLEIN, R (1895)—Ueber die in Wiederkauermagen vorkommenden Ciliaten-Infusorien *Z wiss Zool*, LIX, pp 233–304, pls xvi–xviii

EDDY, S (1928)—Succession of protozoa in cultures under controlled conditions *Trans Amer Micr Soc*, XLVII, pp 283–319, pls xxxviii–xliv

EHRENBERG, C G (1829)—Die geographische Verbreitung der Infusions thierchen in Nord-Afrika und West Asien, beobachtet auf Hemprich und Ehrenberg's Reisen *Abhandl d Konigl Akad d Wissensch zu Berlin*, pp 1–20

—— (1830)—Beiträge zur Kenntniss der Organisation der Infusorien und ihrer geograph verbreitung besonders in Sibirien *Abhandl d Konigl Akad d Wissensch zu Berlin*, a d J 1830 (1832), pp 1–88, pls i–viii

EHRENBERG, C G (1831)—Ueber die Entwicklung und die Lebens dauer der Infusionthiere etc *Abhandl d Konigl Akad d Wissensch zu Berlin*, a d J 1831 (1832), pp 1–154, pls i–iv

—— (1833)—Dritter Beitrag zur Erkenntn grosser Organisation in der Richtung des kleinsten Raumes *Abhandl d Konigl Akad d Wissensch zu Berlin*, a d J 1833 (1835), pp 145–336, pls i–xi

—— (1835)—Zusätze zur Erkenntniss grosser organischer Ausbild in den kleinsten thier Organismen *Abhandl d Konigl Akad d Wissensch zu Berlin*, a d J 1835 (1837), pp 150–80

—— (1837)—Zusätze zur Erkenntniss grosser organischer Ausbild in den kleinsten their-Organismen *Abhandl d Konigl Akad d Wissensch*, pp 145–336

—— (1838)—Die Infusionsthierchen als vollkommene Organismen Leipzig 64 pls

—— (1840)—Diagnose von 274 neuen Infusoiren *Monatsb d k Preuss Akad d Wissensch z Berlin*, pp 197–219

—— (1853)—Ueber die neuerlich bei Berlin vorgekommenen neuen Formen des mikrosk Lebens *Monatsb d K Preuss Akad d Wissensch z Berlin*, pp 183–94

EIDMANN, H (1922)—Neue oder wenig bekannte Protisten—VI Neue oder wenig bekannte Ciliaten—I Neue Cothurnien *Arch Protistenk*, XLV, pp 419–30, 12 figs

EISENBERG HAMBURG, E (1929)—Recherches comparatives sur le fonctionnement de la vacuole pulsatile chez les infusoires parasites de la grenouill et chez les infusoires d'eau douce Influence de la pression osmotique, des électrolytes et du pH *Arch Protistenk*, LXVIII, pp 451–70, 2 figs

ENGELMANN, TH W (1860)—Ueber Fortpflanzung von *Epistylis crassicollis, Carchesium polypinum* und uber Cysten auf d Stocken d letzteren Thieres *Z wiss Zool*, X, p 278, pl xxii

—— (1862)—Zur Naturgeschichte der Infusorien *Z wiss Zool*, XI, pp 347–93

—— (1876)—Über Entwicklung und Fortpflanzung der Infusorien *Morph Jahrb*, I, pp 573–635

ENRIQUES, P (1908 *a*)—Die Conjugation und sexuelle Differenzierung der Infusorien *Arch Protistenk*, XII, pp 213–76, pls xvii–xviii & 6 text figs

—— (1908 *b*)—Sulla morfologie E Sistemica del Genera *Colpoda Arch Zool exp gén*, Notes et Rev, (4) VIII, pp i–xv, 10 figs

—— (1912)—Il dualismo nucleare negli Infusori e il suo significato morfologico e funzionale Abh 2 Die Nahrung und die Struktur des Macronucleus *Arch Protistenk*, XXVI, pp 420–34, pl xxiv

ENTZ G, sen (1879)—Ueber einige Infusorien des Salzteiches zu Szamosfalva *Természetr Fuz*, III, pp 33–72

—— (1882)—Beiträge zur Kenntniss der Infusorien *Z wiss Zool*, XXXVIII, pp 167–89, pl viii

—— (1884)—Ueber Infusorien des Golfes von Neapel *Mt z Stat Neap*, V, pp 289–444, pls xx–xxv

—— (1885)—Zur näheren Kenntniss der Tintinniden *Mt z Stat Neap*, VI, pp 185–216, pls xiii & xiv

ENTZ, G, jun (1909 *a*)—Studien uber Organisation und Biologie der Tintinniden *Arch Protistenk*, XV, pp 93–226, pls viii–xxi & 2 text figs

—— (1909 *b*)—Die Susswasser-Tintinniden *Math naturw Ber Ung* XXV, pp 197–225, 4 pls

ENTZ, G, jun (1913)—Ueber Organisationsverhaltnisse von *Nyctotherus piscicola* (Daday) *Arch Protistenk*, XXIX, pp 364–86, 26 figs

ERDMANN, R (1927)—Endomixis bei *Paramecium bursaria* *Sitz Ber Ges naturf Fr Berl*, 1925, pp 24–7

—— & WOODRUFF, L L (1914)—Vollstandig periodische Erneuerung des kernapparates ohne Zellverschmelzung bei reinlinigen Paramæcien *Biol Zbl*, XXXIV, pp 484–96

—— —— (1917)—The periodic reorganization process in *Paramecium caudatum* *J Exp Zool*, XX, pp 59–97, 7 pls

ERLANGER, R V (1890)—Zur Kenntniss einiger Infusorien *Z wiss Zool*, XLIX, pp 649–62, pl xxix

EYFERTH, B, & SCHOENICHEN, W (1909)—Einfachste Lebensformen das Tier und Pflanzenreiches, IV Auflage

FABRE DOMERGUE, P (1886)—Note s la *Microthorax auricole* n sp *Ann Sci nat Paris*, VI Ser, XIX

—— (1888)—Recherches anatomiques et physiologiques sur les infusoires ciliés *Ann Sci nat Paris*, (7) V, pp 1–140

—— (1889)—Two new Infusorians. *Ann Microgr*, II, pp 353–7 (*J R Micr Soc*, p 535)

—— (1891 *a*)—Études sur la *Trachelius ovum* *J Anat Paris*, XXVII, pp 74–94

—— (1891 *b*)—Matériaux pour servir a l'histoire des Infusoires cilies *Ann Microgr*, III, pp 49–61 & 209–19, 1 pl (*J R Micr Soc*, p 355)

FANTHAM, H B (1926)—Some parasitic Protozoa found in South Africa—IX *S Afr J Sci*, XXIII, pp 364–86, 560–70, 7 figs

—— & PORTER, A (1914)—Some minute animal parasites, or, unseen foes in the animal world London

—— & ROBERTSON, K G (1928)—Some Protozoa found in South Africa—XI *S Afr J Sci*, XXV, pp 351–8, 1 pl

FARKAS, B (1924)—Beiträge zur Kenntnis der Suctorien *Arch Protistenk*, XLVIII, pp 125–35, pl vii, 1 text fig

FAURÉ FREMIET, E (1904)—Sur le pedoncle de quelques Vorticelles *C R Acad Sci Paris*, CXXXVIII, pp 994–6

—— (1905)—La structure de l'appareil fixateur chez les Vorticellidæ *Arch Protistenk*, pp 207–26, 13 figs

—— (1908)—Le *Tintinnidium inquinilum* *Arch Protistenk*, XI, pp 225–51

—— (1909 *a*)—L'*Ancystropodium Maupasi* (nov gen, nov sp) *Arch Protistenk*, XIII, pp 121–38, 7 figs

—— (1909 *b*)—Constitution du macronucleus des Infusoires cilies *C R Acad Sci Paris*, CXLVIII, pp 659–61

—— (1914)—Deux Infusoires planctioniques *Tontonia appendiculariformis* (n gen, n sp) et *Climacostomum diedrum* (n sp) *Arch Protistenk*, XXXIV, pp 95–107, 8 figs

—— (1923)—Contribution à la connaissance des infusoires planktoniques *Bull Biol France Belg*, Supplement VI, pp 1–171, 57 figs

—— (1930)—Growth and differentiation of the colonies of *Zoothamnium alternans* *Biol Bull Wood's Hole*, LVIII, pp 28–51, 18 figs

—— (1932)—Division et morphogenèse chez *Folliculina ampulla* *Bull Biol France Belg*, LXVI, pp 77–110, 17 figs

FERBER, K E, & WINOGRADOWA-FEDORÓWA, T (1929)—Zählung und Teilungsquote der Infusorien im Pansen der Wiederkäuer *Biol Zbl*, XLIX, pp 321–8

FILIPJEV, J (1911)—Zur Organisation von *Tocophrya quadripartita* Cl & L *Arch Protistenk*, XXI, pp 117–42, pl viii, 1 text fig

FINLEY, H E (1934)—On the vacuome in three species of *Vorticella*. *Trans Amer Micr Soc*, LIII, pp 57–66, 1 pl

FIORENTINI, A (1889)—Interno ai Protisti dello stomaco dei Bovini. Pp 1–27, pls i–vi

—— (1890 *a*)—Sur les Protistes de l'Estomac des Bovides *J. Microgr*, XIV, pp 23–28, 79–83, 178–83, 3 pls

—— (1890 *b*)—Intorno ai Protisti dell'Intestino degli Equini *Boll. scient*, XII, pp 7–17, 51–60, 2 pls

FOCKE, G W (1836)—Über einige Organisations-verhaltnisse den polygastrichen Infusoiren und Raderthieren *Isis*, pp 786–7

—— (1843)—Ueber die niedersten wirbellosen Thiere Antl *Ber der Vers deutsch Naturf u Aerzte zu Mainz*, pp 227–8

FOETTINGER, A (1881)—Recherch s quelques infusoires nouv parasites des Cephalopodes *Arch Biol*, II, pp 351–78

FORTNER, H (1926)—Zur Morphologie und Physiologie des Vorticellenstieles *Z wiss Zool*, CXXVIII, pp 114–32, 6 figs

—— (1928)—Zur Kenntnis der Verdaungsvergänge bei Protisten Studie an *Paramæcium caudatum* *Arch Protistenk*, LXI, pp 282–92, 5 figs

FOULKE, S G (1884)—A new species of *Trachelius* *Proc Acad Nat. Sci Philad*, pp 51–2

—— (1885 *a*)—An Endoparasite of *Noteus* (*Anoplophrya notei*) Sillim's *Amer J of sci and arts*, XXX, pp 377–8

—— (1885 *b*)—*Trachelius ovum* *J N Y Micr Soc*, I, pp 97–8

FOUQUET, D (1876)—Note sur une espèce d'infusoires parasites des poissons d'eau douce *Arch Zool exp gén*, V, pp 159–65, pl v

FRANCHINI, J (1933)—Balantidiose humaine *Bull Soc Path exot*, XXVI, pp 175–8

FRESENIUS, G (1858)—Beiträge z Kenntniss mikrosk Organismen. *Abh Senkenb naturf Ges*, II, pp 211–42

—— (1865)—Die Infusorien des Seewasseraquariums *Zool Gart.* VI, pp 81–9

FROMENTEL, E DE (1874)—Études sur les Microzoaires ou infusoires propermént dits Paris

FURSSENKO, A (1929)—Lebencyclus und Morphologie von *Zoothamnium arbuscula* Ehrenberg (Infusoria Peritricha) *Arch Protistenk*, LXVII, pp 376–500, 6 pls, 57 text figs

GĂJEWSKAJA, N (1933)—Zur Oekologie, Morphologie und Systematik der Infusorien des Baikalsees *Zoologica*, Stuttgart, XXXII, pp 1–298, 25 pls

GATENBY, J B, & COWDRY, E V (1928)—Bolles Lee's Microtomist's Vade Mecum Ninth edition London

—— & KING, S D (1925)—*Opalina ranarum* a Flagellate *Nature*, CXVI, p 712

GEGENBAUR, C (1857)—Bemerkungen über *Trachelius ovum* *Arch. Anat Physiol Lpz*, pp 309–12

GEIMAN, Q M (1931)—Morphological variations in *Coleps octospinus*. *Trans Amer Micros Soc*, L, pp 136–43, pl xiv

GELEI, J v (1925 *a*)—Ein neues Paramœcium aus der Umgebung von Szeged *Paramæcium nephridiatum* n sp *Allatt Közl*, XXII, pp 121–59, 15 figs (German *résumé*, pp 245–6)

—— (1925 *b*)—Über den Kannibalismus der Stentoren *Arch Protistenk*, LII, pp 404–17, 8 figs

—— (1928)—Nochmals uber den Nephridialapparat bei den Protozoen *Arch Protistenk*, LXIV, pp 479–94, pl xiii & 5 text-figs

—— (1929 *a*)—Ein neuer Typ der hypotrichen Infusorien aus der Umgebung von Szeged *Spirofilum tisiæ* n sp, n gen, n fam *Arch Protistenk*, LXV, pp 165–82, pl viii & 6 text-figs

—— (1929 *b*)—Sensorischer Basalapparat der Tastborsten und der Syncilien bei Hypotrichen *Zool Anz*, LXXXIII, pp. 275–80, 5 text figs

—— (1932 *a*)—Eine neue Goldmethode zur Ciliatenforschung und eine neue Ciliate *Colpidium pannonicum* *Arch Protistenk*, LXXVII, pp 219–30, 6 figs

—— (1932 *b*)—Beiträge zur Ciliatenfauna der Umgebung von Szeged — I *Nassula tricirrata* sp n II Einige Blepharismen (Hungarian, with German summary) *Acta biol*, *Szeged*, II, pp 162–4, 2 figs, pp 169–94, 10 figs

—— (1934)—Der feinere Bau des Cytopharynx von *Paramecium* und seine systematische Bedeutung *Arch Protistenk*, LXXXII, pp 331–62, pl viii and 17 text-figs

—— (1935)—*Colpidium glaucomæforme* n sp (*Hymenostomata*) und sein Neuronemensystem *Arch Protistenk*, LXXXV, pp 289–302, 16 figs

—— & HORVÁTH, P (1931)—Eine nasse Silber bzw Goldmethode fur die Herstellung der reizleitenden Elemente bei den Ciliaten *Z wiss Mikr*, XLVIII, pp 9–29, 3 pls

†GHOSH, E (1918)—Studies on Infusoria *Rec Indian Mus*, XV, pp 129–34

†—— (1919 *a*)—Do —II *Rec Indian Mus*, XVI, pp 41–3

†—— (1919 *b*)—On three new species of *Opalina* Purk et Val *Proc Indian Ass Cult Sci*, IV, pp 102–8, pls i–ii

†—— (1920 *a*)—Infusoria from Bengal *Report Sci Convention Indian Ass Cult Sci* for 1918, pp 144–9

†—— (1920 *b*)—Cytology of *Opalina scalpriformis* Ghosh *Indian J Med*, I, pp 78–84, 2 pls.

†—— (1921 *a*)—Infusoria from the environment of Calcutta —I *Bull Carmichael Med Coll*, II, pp 6–17

†—— (1921 *b*)—New Hypotrichous Infusoria from Calcutta *J R Micr Soc*, pp 248–50

†—— (1922 *a*)—On a new Ciliate, *Balantidium blattarum*, sp nov, intestinal parasite in the common cockroach (*Blatta americana*) *Parasitology*, XIV, pp 15–16

†—— (1922 *b*)—On a new Ciliate, *Balantidium ovatum*, sp nov, an intestinal parasite in the common cockroach (*Blatta americana*) *Parasitology*, XIV, p 371

†——(1922 c)—A new parasitic ciliate Protozoon *Indian J Med*, III, p 284, fig 1

†Ghosh, E (1922 *d*) —New species of *Vorticella* from Calcutta *Bull Carmichael Med Coll*, III, pp 8–18, pls i–iii

†—— (1923) —On a new species of *Scyphidia* (*S purniensis*) *J R Micr Soc*, p 74

†—— (1925) —On a new Ciliate, *Balantidium Knowlesii*, a cœlomic parasite in *Culicoides peregrinus* *Parasitology*, XVII, p 189

†—— (1928) —Two new Ciliates from sewer water *J R Micr Soc*, pp 382–4

†—— (1929 *a*) —A new species of *Balantidium* from the intestine of the Bengal Monkey (*Macacus rhesus*) *J R Micr Soc*, p 14

†—— (1929 *b*) —A new Ciliate from the intestine of the common Bengal Monkey (*Macacus rhesus*) *J R Micr Soc*, pp 15–16

†—— (1929 *c*) —Two new Suctoria from sewer water *J R Micr Soc*, pp 222–3, figs 1 & 2

Giese, A C, & Taylor, C V (1935) —Paramecia for experimental purposes in controlled mass cultures on a single strain of bacteria *Arch Protistenk*, LXXXIV, pp 225–31, 1 fig

Glaser, R W, & Coria, N A (1933) —The culture of *Paramecium caudatum* free from living micro organisms *J Parasit*, XX, pp 33–7

—— (1935) —The Partial Purification of *Balantidium coli* from Swine *J Parasit*, XXI, pp 190–3

Gmelin, J (1791) —Systema Naturæ, ed 13, 1 v 6

Goldfuss, G A (1820) —Handbuch der Zoologie Nurnberg

Goldsmith, W M (1922) —The process of ingestion in the ciliate *Frontonia* *J Exp Zool*, XXXVI, pp 333–46, 3 pls

Gonder, R (1905) —Beitrage zur Kenntnis der Kernverhaltnisse bei den in Cephalopoden schmarotzenden Infusorien *Arch Protistenk*, V, pp 240–62

—— (1910) —Ein Parasit von *Colpoda cucullus* *Arch Protistenk*, XVIII, pp 275–7, 2 figs

Goodey, T (1913) —The excystation of *Colpoda cucullus* from its resting cysts, and the nature and properties of the cyst membranes *Proc Roy Soc*, B, LXXXVI, pp 427–39

Gosse, Ph H (1857) —On the zoological position of *Dysteria* *Quart J Micr. Sci*, V, pp 138–9

Gourret, P, & Roeser, P (1886) —Les protozoaires du vieux-port de Marseille *Arch Zool exp gén*, (2) IV, pp 443–534, 8 pls

Gourvitsch, V (1926) —La faune de Protozoaires de l'intestin des grenouilles des environs de Taschkent *Bull Univ Asie cent T*, XIV, pp 47–61, pls iv–v

†Grant, G W (1842) —In Th Cantor's paper on General features of Chusan, with remarks on the flora and fauna of that island *Ann Mag Nat Hist*, IX, pp 265–78, 361–70, 481–93

Grassé, P P (1928) —Sur quelques *Nyctotherus* (Infusoires hétérotriches) nouveau ou peu connus *Ann Protistologie Paris*, I, pp 55–68, pl i, 4 text figs

Grassé, P, & Boissezon, P de (1929) —*Turchiniella culcis* n g, n sp, Infusoire parasite de l'hemocœle d'un *Culex* adulte *Bull Soc zool Fr*, LIV, pp 187–91, 6 figs

Gray, J (1929) —The mechanism of ciliary movement *Amer Nat*, LXIII, pp 68–81

GRAY, P (1932)—A rapid technique for the permanent mounting of minute fresh-water organisms *J R Micr Soc*, LII, pp 370–2

GREEF, R (1888)—Studien uber Protozoen—II Land-Infusorien. *Sitz Ber Ges Naturw Marburg*, pp 125–35

GRUBER, A (1883)—Beobachtungen an *Chilodon curvidentis* *Festschrift d 56 Vers deutsch Naturf gewidm von d naturf Gesellsch zu Freiburg*, pp 38–48

—— (1884)—Die Protozoen des Hafens von Genua *Nova Act Leop Carol*, XLVI, 67 pp, 5 pls

—— (1886)—Der Conjugationsprocess bei *Paramæcium Aurelia* *Ber naturf Ges Freiburg*, II, pp 7–24

—— (1887)—Weiters Beobachtungen an vielkernigen Infusorien *Ber naturf Ges Freiburg*, III, pp 57–70

GRUBY & DELAFOND (1843)—Sur les animalcules se developp d les intestins pend la digest des anim herbivores et carnivores *C R Acad Sci Paris*, XVII, pp 1304–8

†GULATI, A N (1925)—An account of some fresh-water ciliates from Lahore *J Bombay Nat Hist Soc*, XXX, pp 744–55, 2 pls

†—— (1933)—Multiplication of *Nyctotherus macropharyngeus* *Arch Protistenk*, LXXX, pp 367–9, 2 figs

GUNTHER, A (1899)—Untersuchungen uber die im Magen unserer Hauswiederkäuer vorkommenden Wimperinfusorien *Z wiss Zool*, LXV, p 529 *et seq* (*J R Micr Soc*, p 407)

—— (1900)—Weitere Beiträge zur Kenntniss des feineren Baues einiger Infusorien aus dem Wiederkäurmagen und dem Cœcum des Pferdes *Z wiss Zool*, LXII, pp 640–62, pls xxxvi & xxxvii

HAAS, G (1933)—Beiträge zur Kenntnis der Cytologie von *Ichthyophthirius multifiliis* Fouq *Arch Protistenk*, LXXXI, pp 88–137, 2 pls, 43 text figs

HACKEL, E (1873 *a*)—Zur Morphologie der Infusorien *Jena Z. Naturw*, VII, pp 516–60

—— (1873 *b*)—Ueber einige neue pelagische Infusorien *Jena Z Naturw*, pp 561–8, pls xxvii & xxviii

HADA, Y (1932)—Report of the biological survey of Mutsu Bay—24 The pelagic Ciliata, Suborder Tintinnoinea *Sci Rep Tôhoku Imp Univ*, (4 ser) VII, pp 553–73, 26 figs

HALL, R P, & ALVEY, C H (1933)—The vacuome and so called canalicular system of *Colpidium* *Trans Amer Micr Soc*, LII, pp 26–32, 6 figs

—— & DUNIHUE, F P (1931)—On the Vacuome and Food Vacuoles in *Vorticella* *Trans Amer Micr Soc*, L, pp 196–205

—— & NIGRELLI, R F (1930)—Relation between mitochondria and food vacuoles in the ciliate *Vorticella* *Trans Amer Micr Soc*, XLIX, pp 54–57, 1 fig

HAMBURGER, C (1903)—Beiträge zur Kenntnis von *Trachelius ovum*. *Arch Protistenk*, II, pp 445–74, pls xiii & xiv, 4 text figs

—— (1904)—Die Conjugation von *Paramæcium bursaria* Focke *Arch Protistenk*, IV, pp 199–239, pls vii–ix & 2 text-figs

—— & BUDDENBROCK, W VON (1911)—Nordische Ciliata mit Ausschluss der Tintinnoidea In *Nordisches Plankton*, Lfg 15. Kiel & Leipzig No xiii, pp 1–152

HANCE, R T (1917)—Studies on a Race of *Paramœcium* possessing extra Contractile Vacuoles —I An account of the morphology, physiology, genetics, and cytology of this new race *J Exp Zool*, XXIII, pp 287–333, 3 pls

HARGITT, G T, & FRAY, W (1917)—The growth of *Paramœcium* in pure cultures of bacteria *J Exp Zool*, XXII, pp 421–55

HARTMANN, M (1928)—Pratikum der Protozoologie Funfte Auflage Jena Pp 1–181, 136 text figs

HARTOG, M (1902)—Notes on Suctoria *Arch Protistenk*, I, pp 372–4

—— (1906)—Protozoa Cambridge Natural History—I London

HAUGHWOUT, F G (1918)—The Protozoa of Manila and the vicinity—I *Philipp J Sci*, XIII, pp 175–214

HAUSMANN, L A (1917)—Observations on the Ecology of the Protozoa *Amer Nat*, LI, pp 157–72

HEGNER, R W (1922)—Frog and toad tadpoles as sources of intestinal Protozoa for teaching purposes *Science*, LVI, pp 439–41

—— (1932)—Observations and experiments on the Opalinid Ciliates of the green frog *J Parasit*, XVIII, pp 274–7

—— (1934)—Specificity in the genus *Balantidium* based on size and shape of body and macronucleus, with descriptions of six new species *Amer J Hyg*, XIX, pp 38–67, 55 figs

—— & ANDREWS, J (1930)—Problems and methods of research in protozoology New York Pp ix+532, 32 figs

—— & CHU, H J (1930)—A comparative study of the intestinal protozoa of wild monkeys and man *Amer J Hyg*, XII, pp 62–108, 2 pls

—— & HOLMES, F O (1923)—Observations on a *Balantidium* from a Brazilian monkey, *Cebus variegatus* E Geoffr, with special reference to chromosome-like bodies in the macronucleus *Amer J Hyg*, III, pp 253–63, pls v & vi

—— & HSIANG-FONG WU (1921)—An analysis of the relation between growth and nuclear division in a parasitic infusorian *Opalina* sp *Amer Nat*, LV, pp 335–46

—— & REES, C W (1933)—*Taliaferria clarki*, a new genus and species of ciliate from the cecum of the red spider monkey, *Ateles geoffroyi* Kuhl *Trans Amer Micr Soc*, LII, pp 317–21, 1 pl

—— & TALIAFERRO, W H (1924)—Human Protozoology New York Pp 1–597

HEIDENREICH, E (1935 *a*)—Untersuchungen an parasitischen Ciliaten aus Anneliden *Arch Protistenk*, LXXXIV, pp 315–92, pls vi–ix, 15 text figs, pp 393–414, 10 text figs

—— (1935 *b*)—Ergänzende Untersuchungen an parasitischen Ciliaten aus Oligochaten *Arch Protistenk*, LXXXIV, pp 528–32, 3 figs

—— (1935 *c*)—*Ptychostomum lumbriculi* n sp *Arch Protistenk*, LXXXV, pp 303–5, 2 figs

HENTSCHEL, C C (1924)—On a new Ciliate, *Cryptochilum boreale* nov sp, from the intestine of *Echinus esculentus* Linn, together with some notes on the ciliates of Echinoids *Parasitology*, XVI, pp 321–8, 3 figs

—— (1925)—Notes on *Hoplitophrya* (*Anoplophrya*) *brasili* (Léger & Duboscq), an intestinal Ciliate of the Polychæte worm *Cirrhatulus* *Parasitology*, XVII, pp 217–20

HENTSCHEL, C C (1927)—On a new ciliate, *Ptyssostoma thalassemæ*, nov sp, from the intestine of the echiuroid worm *Thalassema neptuni* Gärtner *J Mar Biol Ass Plymouth*, XIV, pp 651–5, 3 figs

HERFS, A (1922)—Die pulsierende Vakuole der Protozoen ein Schutzorgan gegen Aussüssung Studien über Anpassungen der Organismen an das Leben im Süsswasser *Arch Protistenk*, XLIV, pp 227–60

HERTWIG, R (1889)—Über die Conjugation der Infusorien *Abh bayer Akad Wiss*, XVII, pp 151–233

—— (1914)—Über Parthenogenesis der Infusorien und die Depressionzustande der Protozoen *Biol Zbl*, XXXIV, pp 557–81

—— & LESSER, E (1874)—Ueber Rhizopoden und denselben nahestehenden Organismen *Arch mikr Anat*, X, pp 35–243, pls iii–iv

HETHERINGTON, A (1932)—The constant culture of *Stentor cœruleus* *Arch Protistenk*, LXXVI, pp 118–29

—— (1933)—The culture of some holotrichous ciliates *Arch Protistenk*, LXXX, pp 255–80, 1 fig

—— (1935)—The pure culture of *Paramecium* *Science*, LXXIX, pp 413–14

HICKSON, S J (1903)—The Infusoria, in Lankester's System of Zoology, Part I, 2nd Fascicle, London, pp 361–426, 97 figs

—— & WADSWORTH, J T (1909)—*Dendrosoma radians* Ehrbg *Q J Micr Sci*, LIV, pp 141–83, pl x

HIGGINS, H T (1929)—Variations in the *Nyctotherus* (Protozoa, Ciliata) found in frog and toad tadpoles and adults *Trans Amer Micr Soc*, XLVIII, pp 141–57, 4 pls

HILL, J (1752)—History of Animals, including the several classes of Animalcula visible only by the assistance of the Microscope London

HOARE, C A (1927 *a*)—Studies on coprozoic ciliates *Parasitology*, XIX, pp 154–222, pls ix–xiii, 3 text figs

—— (1927 *b*)—Schewiakoff's keys for the determination of the Holotrichous Ciliates (Translated from the Russian) *Proc Zool Soc Lond*, pp 399–418

—— (1930)—Ciliates (Ophryoscolecidæ) from the stomachs of African ruminants *Trans R Soc Trop Med Hyg*, XXIV, p 3

HOFKER, J (1931)—Studien über *Tintinnoidea* *Arch Protistenk*, LXXV, pp 315–402, 89 figs

HOLLIS, H B (1922)—Biologia del *Chilodon cucullatus* *Rev mex Biol*, III, pp 3–7

HOPKINS, H S (1921)—The conditions for conjugation in diverse races of *Paramecium* *J Exp Zool*, XXXIV, pp 339–84

HORNING, E S (1925)—The mitochondria of a Protozoan (*Opalina*) and their behaviour during the life cycle *Aust J Exp Biol med Sci*, II, pp 167–71, 2 pls

—— (1926 *a*)—Studies on the mitochondria of *Paramæcium* *Aust J Exp Biol Med Sci*, III, pp 89–95, 1 pl

—— (1926 *b*)—Observations on Mitochondria. *Aust J Exp Biol Med Sci*, III, pp 149–59, 7 figs

—— (1927 *a*)—Mitochondrial behaviour during the life cycle of *Nyctotherus cordiformis* *Aust J Exp Biol Med Sci*, IV, pp 69–73, 1 pl

HORNING, E S (1927 *b*)—On the relation of mitochondria to the nucleus *Aust J Exp Biol Med Sci*, IV, pp 75–8, 1 pl

—— (1927 *c*)—On the orientation of mitochondria in the surface cytoplasm of Infusorians *Aust J Exp Biol Med Sci*, IV, pp 187–90, 1 pl

HORVÁTH, J v (1932)—Ein neues hypotriches Infusor, *Kahlia acrobates* nov gen, nov sp *Arch Protistenk*, LXXVII, pp 424–33, 6 figs

—— (1933)—Beiträge zur hypotrichen Fauna der Umgebung von Szeged—I *Arch Protistenk*, LXXIX, pp 281–302, 15 figs

HSIUNG, T S (1929)—On *Didesmis spiralis*, sp nov, a new ciliate from the large intestine of the horse *Trans Amer Micr Soc*, XLVIII, pp 209–13, 1 pl

—— (1930 *a*)—A monograph on the Protozoa of the large intestine of the horse *Iowa St Coll J Sci*, IV, pp 356–423

—— (1930 *b*)—Some new ciliates from the large intestine of the horse *Trans Amer Micr Soc*, XLIX, pp 34–41, 1 pl

—— (1932)—A general survey of the Protozoan fauna of the rumen of the Chinese cattle *Bull Fan Memorial Inst Biol Peiping*, III, pp 87–107, figs

HUXLEY, T H (1857)—On *Dysteria*, a new genus of infusoria *Quart J Micr Sci*, V, pp 78–82

HYMAN, L H (1925)—Methods of securing and cultivating Protozoa—I General statements and methods *Trans Amer Micr Soc*, XLIV, pp 216–21

—— (1931)—Do—II *Paramecium* and other Ciliates *Trans Amer Micr Soc*, L, pp 50–7

ILOWAJSKY, S A (1926 *a*)—Über die kernprozesse der getrennter Conjuganten der *Stylonichia mytilus* und *Paramæcium caudatum* *Arch Protistenk*, LIII, pp 243–52, 12 figs

—— (1926 *b*)—Material zum Studium der Cysten der Hypotrichen *Arch Protistenk*, LIV, pp 92–136, pls v–vi, 4 text figs

IVANIĆ, M (1924)—Über die promitotische Teilung des Synkaryons der Exconjuganten von *Chilodon cucullus* (O F M) *Arch Protistenk*, XLIX, pp 297–300, 4 figs

—— (1928 *a*)—Über die mit den parthenogenetischen Reorganisationsprozessen des Kernapparates verbundenen Vermehrungscysten von *Chilodon uncinatus* Ehrbg *Arch Protistenk*, LXI, pp 293–348, pls x–xii, 1 text fig

—— (1928 *b*)—Bau und Teilung des Kernapparates bei *Colpidium colpoda* St *Zool Anz*, LXXV, pp 67–78, 12 figs

—— (1929 *a*)—Über die centrosomenahnlichen Gebilde bei der Grosskernteilung und die promitotische Kleinkernteilung, nebst Bemerkungen uber die Chromosomenverhaltnisse bei einem Infusor (*Euplotes patella* Ehrbg) *Arch Protistenk*, LXVI, pp 33–60, 2 pls, 4 text figs

—— (1929 *b*)—Zur Auffassung der sog bandformigen Grosskerne bei Infusorien, zugleich ein Beitrag zur Kenntnis der sog parthenogenetischen und ihnen ähnlichen Reorganisations prozesse des Kernapparates bei Protozoen *Arch Protistenk*, LXVI, pp 133–59, 2 pls, 3 text-figs

—— (1931 *a*)—Bau des ruhenden Kleinkernes und seine Teilung bei *Stylonychia pustulata* Ehrbg *Zool Anz*, XCIII, pp 81–94, 7 figs

IVANIĆ, M (1931 *b*)—Encystierung und Bau der fertiggebildeten Ruhecysten von *Euplotes patella* Ehrbg *Zool Anz*, XCV, pp 77–87, 7 figs

—— (1933 *a*)—Neue Beiträge fur Kenntnis der mit den Reorganisationsprozessen des Kernapparates verbunden Vermehrungsruhestadien von *Chilodon uncinatus* *Arch Protistenk*, LXXIX, pp 170–99, 1 pl

—— (1933 *b*)—Die Conjugation von *Chilodon cucullulus* Ehrbg *Arch Protistenk*, LXXIX, pp 313–48, 37 figs

—— (1934 *a*)—Ein Beitrag zur Kenntnis der im Enddarme des Laubfrosches (*Hyla arborea* L) lebenden Opaline, *Opalina obtrigona* Stein *Zool Anz*, CVII, pp 296–306, 24 figs

—— (1934 *b*)—Ueber die Ruhestadienbildung und die damit am Kernapparate verbundenen Veranderungen bei *Lionotus cygnus* O F M (*Amphileptus anser* Ehrbg) *Zool Anz*, CVIII, pp 17–22, 7 figs

JACOBSON, I (1931)—Fibrillare Differenzierungen bei Ciliaten *Arch Protistenk*, LXXV, pp 31–100, pls iv–x, 36 text figs

†JAMESON, A P (1925 *a*)—A new Ciliate, *Charon ventriculi* n g, n sp, from the stomach of ruminants *Parasitology*, XVII, pp 403–5

†—— (1925 *b*)—A note on the ciliates from the stomach of the mouse deer (*Tragulus meminna*), with the description of *Entodinium ovalis* n sp *Parasitology*, XVII, pp 406–9, 1 fig

—— (1926)—A ciliate, *Buxtonella sulcata* n g, n sp, from the cæcum of cattle *Parasitology*, XVIII, pp 182–6, 6 figs

—— (1927)—The behaviour of *Balantidium coli* Malm in cultures *Parasitology*, XIX, pp 411–19, 15 figs

JAROCKI, J (1934)—Two new hypocomid ciliates, *Heterocineta janickii* sp n and *H lwoffi* sp n, ectoparasites of *Physa fontinalis* (L) and *Viviparus fasciatus* Muller *Mém Acad Polon Cracovie*, B, pp 167–87

—— & JAKUBOWSKA, W (1927)—Eine neue, solitar freischwimmende Peritriche, *Hastatella æsculacantha* n sp *Zool Anz*, LXIII, pp 270–80, 3 figs

—— & RAABE, Z (1932)—Ueber drei neue Infusorien Genera der Familie Hypocomidæ (Ciliata Thigmotricha), Parasiten in Susswassermuscheln *Bull int Acad Cracovie*, B II, pp 29–45, 8 figs (Abstract in *C R Acad Cracovie*, II, pp 6–7)

JENNINGS, H S (1912)—Age, Death and Conjugation in the light of the work on lower organisms *Pop Sci Mon*, pp 563–77

JIROVEC, O (1930)—Über ein neues *Balantidium* aus dem Darmtractus von *Amblystomum tigrinum* *Z Parasitenk*, III, pp 17–21, 10 figs

JOLLOS, V (1913 *a*)—Über die Bedeutung der Conjugation bei Infusorien Kritische Bemerkungen anlasslich der Untersuchungen von H S Jennings *Arch Protistenk*, XXX, pp 328–34

—— (1913 *b*)—Experimentelle Untersuchungen an Infusorien (Vorl Mitt) *Biol Zbl*, XXXIII, pp 222–36

—— (1916)—Die Fortpflanzung der Infusorien und die potentielle Unsterblichkeit der Einzelligen *Biol Zbl*, XXXVI, pp 497–514

JONES, E P (1930)—*Paramœcium* infusion histoires—I Hydrogen ion changes in hay and hay-flour infusions *Biol Bull Wood's Hole*, LIX, pp 275–84

JORGENSEN, E, & KAHL, A (1931 & 33)—Tintinnidæ Grimpe and Wagler's Tierwelt der Nord- und Ostsee, Leipzig, Teil II, c 1–2, pp 1–28

JUDAY, C (1919)—A freshwater anærobic Ciliate *Biol Bull Wood's Hole*, XXXVI, pp 92–5

KAHL, A (1926)—Neue und wenig bekannte Formen der holotrichen und heterotrichen Ciliaten *Arch Protistenk*, LV, pp 197–438, 106 figs

—— (1927 *a*)—Neue und ergänzende Beobachtungen heterotrichten Ciliaten *Arch Protistenk*, LVII, pp 121–203, 41 figs

—— (1927 *b*)—Neue und erganzende Beobachtungen holotrichen Ciliaten—I *Arch Protistenk*, LX, pp 34–129, 21 figs

—— (1930 *a*)—*Metopus*, eine interesante Infusorien gattung (Infusoria Heterotricha) *Mikrokosmos*, XXIV, pp 7–12, 2 pls

—— (1930 *b*)—Neue und ergänzende Beobachtungen holotrichen Ciliaten—II *Arch Protistenk*, LXX, pp 313–416, 12 figs

—— (1930–5)—Wimpertiere oder Ciliata (Infusoria) Eine Bearbeitung der freilebenden und ectocommensalen Infusorien der Erde In Dahl's Tierwalt Deutschlands, Jena Pp 1–180 (1930), 181–398 (1931), 399–650 (1932), 651–886 (1935)

—— (1932)—*Ctenostomata* (Lauterborn) n subordo Vierte Unterordnung der *Heterotricha* *Arch Protistenk*, LXXVII, pp 231–304, 35 figs

—— (1933)—Ciliata libera et ectocommensalia Grimpe & Wagler's Tierwelt der Nord- und Ostsee, Leipzig, Lfg XXIII, pp 29–146, 888 figs in 26 plates

—— (1934 *a*)—Ciliata entocommensalia et parasitica Grimpe & Wagler's Tierwelt der Nord- und Ostsee, Leipzig, Lfg XXVI, pp 147–83, 138 figs in 9 pls

—— (1934 *b*)—Suctoria Grimpe & Wagler's Tierwelt der Nord und Ostsee Leipzig, Lfg XXVI, pp 184–226, 228 figs in 9 pls

KALMUS, H (1929 *a*)—Beobachtungen und Versuche uber die Tätigkeit kontraktilen Vakuole eines marinen Infusors *Amphileptus gutta* Cohn, nebst morphologischen und systematischen Vorbemurkungen *Arch Protistenk*, pp 409–20, 4 figs

—— (1929 *b*)—*Bursalinus synspiralis*, ein neues heterotriches Infusor aus dem Salinenschlaum *Arch Protistenk*, LXVIII, pp 609–12, 1 fig

KALTENBACH, R (1915)—Die conjugation von *Ophrydium versatile* (Vorlaufige Mitteilung) *Arch Protistenk*, XXXVI, pp 67–71, 8 figs

KASANZEFF, W (1910)—Zur Kenntnis von *Loxodes rostrum* *Arch Protistenk*, XX, pp 79–96, pl viii & 4 figs

TEN KATE, C G B (1927)—Über das Fibrillensystem der ciliaten *Arch Protistenk*, LVII, pp 362–426, 53 figs

—— (1928)—Do 2 Das Fibrillensystem der Isotrichen (*Isotricha* und *Dasytricha*) *Arch Protistenk*, LXII, pp 328–54, 41 figs

KEILIN, D (1920)—On the occurrence of a supplementary chromatic body in *Maupasella nova* Cépède (Ciliata Astomata), an intestinal parasite of earthworms (*Allolobophora caliginosa* Savigny) *Parasitology*, XII, pp 92–4, pl vi

KEILIN, D (1921)—On a new ciliate *Lambornella stegomyiæ* n g, n sp, parasitic in the body cavity of the larvæ of *Stegomya scutellaris* Walker (Diptera, Nematocera, *Culicidæ*) *Parasitology*, XIII, pp 216–24

KENT, W S (1880–2)—A Manual of the Infusoria London

KEPNER, W A, & PICKENS, A L (1925)—*Trichodina steinii* (C & L) from *Planaria polychora* (O Schm) *Biol. Bull Wood's Hole*, XLIX, pp 237–40

KERBERT, C (1884)—*Chromatophagus parasiticus* n g et n sp Ein Beitrag zur Parasitenlehre *Tijdschr ned dierk Ver Leiden*, V, pp 44–58

KHAINSKY, A (1911)—Zur Morphologie und einiger Infusorien (*Paramæcium caudatum*) auf Grund einer neuen histologischen Methode *Arch Protistenk*, XXI, pp 1–60, pls i–iii, 2 text-figs

KIDDER, G W (1933 *a*)—Studies on *Conchophthirius mytili* De Morgan—I Morphology and division—II Conjugation and nuclear reorganization *Arch Protistenk*, LXXIX, pp 1–24, 4 pls, 5 text figs, pp 25–49, 3 pls, 9 text-figs

—— (1933 *b*)—On the genus *Ancistruma* Strand (*Ancistrum* Maupas)—I The structure and division of *A mytili* Qenn and *A isseli* Kahl *Biol Bull Wood's Hole*, LXIV, pp 1–20, 10 figs

—— (1933 *c*)—On the genus *Ancistruma* Strand (=*Ancistrum* Maupas)—II The conjugation and nuclear reorganisation of *A isseli* Kahl *Arch Protistenk*, LXXXI, pp 1–18, 1 pl

—— (1933 *d*)—*Conchophthirius caryoclada* sp nov (Protozoa, Ciliata) *Biol Bull Wood's Hole*, LXV, pp 175–8, 2 figs

—— (1934)—Studies on the ciliates from fresh water mussels—I The structure and neuromotor system of *Conchophthirius anodontæ* Stein, *C curtus* Engl, and *C magna* sp nov—II The nuclei of *Conchophthirius anodontæ* Stein, *C curtus* Engl, and *C magna* Kidder, during binary fission *Biol Bull Wood's Hole*, LXVI, pp 69–90, 9 figs, pp 286–303, 7 figs

—— & DILLER, W F (1934)—Observations on the binary fission of four species of common free living ciliates, with special reference to the macronuclear chromatin, *Biol Bull Wood's Hole*, LXVII, pp 201–19, 6 figs

KING, R L (1928)—The contractile vacuole in *Paramecium trichium* *Biol Bull Wood's Hole*, LV, pp 59–68, pls i & ii

KING, S D (1926)—Note on the cytology of *Anoplophrya brasili*. *Quart J Micr Sci*, LXX, pp 693–700, pl xxxvi

—— (1927)—The Golgi Apparatus of Protozoa *J R Micr Soc* XLVII, pp 342–55, 7 figs

—— & GATENBY, J B (1926)—Note on certain new bodies in *Opalina ranarum*, presumed to represent the Golgi elements *Quart J Micr Sci*, LXX, pp 217–19, pl xvi

KIRBY, H (1928)—Notes on some parasites of Chimpanzees *Proc Soc Exp Biol*, XXV, pp 698–700

—— (1934)—Some ciliates from salt marshes in California *Arch Protistenk*, LXXXII, pp 114–33, 3 pls

KLEIN, B M (1926)—Eregebnisse mit einer Silbermethode bei Ciliaten *Arch Protistenk*, LVI, pp 243–80, 33 figs

—— (1927)—Die Silberlinien system der Ciliaten *Arch Protistenk*, LVIII, pp 55–142, 54 figs

KLEIN, B M (1928)—Die Silberlinien system der Ciliaten Weitere Resultate *Arch Protistenk*, LXII, pp 177–260, 4 pls, 42 figs

—— (1929)—Weitere Beiträge zur Kenntnis des Silberliniensystems der Ciliaten *Arch Protistenk*, LXV, pp 183–257, pl ix, 45 text figs

—— (1930)—Das Silberlinien system der Ciliaten Weitere Ergebnisse—IV *Arch Protistenk*, LXIX, pp 235–326, 1 pl, 47 text figs

KLITZKE, M (1914)—Über Wiederconjuganten bei *Paramæcium caudatum* *Arch Protistenk*, XXXIII, pp 1–20, pls i & ii, 3 text figs

—— (1926)—Ein Beitrag zur Kenntnis der Kernentwicklung bei den Ciliaten *Arch Protistenk*, XXXVI, pp 215–35, 3 figs

†KNOWLES, R (1928)—An Introduction to Medical Protozoology Calcutta Pp 1–887, 15 pls, 174 text figs

†—— & DAS GUPTA, B M (1934)—Some observations on *Balantidium coli* and *Entamœba histolytica* of Macaques *Indian Med Gaz*, LXIX, pp 390–2, 1 pl

†KOFOID, C A (1935)—On two remarkable Ciliate Protozoa from the Cæcum of the Indian Elephant *Proc Nat Acad Sci, Wash*, XXI, pp 501–6, 5 figs

—— & CAMPBELL, A S (1929)—A conspectus of the marine and fresh water ciliata belonging to the sub order Tintinnoidea, with description of new species from the Agassiz Expedition to the Eastern Tropical Pacific 1904–1905 *Univ Calif Publ Zool*, XXXIV, pp 1–403, 697 figs

†—— & CHRISTENSON, J F (1934)—Ciliates from *Bos gaurus* H Smith *Univ Calif Publ Zool*, XXXIX, pp 341–92, pls xxv–xxix, 7 text figs

†—— & MACLENNAN, R F (1930)—Ciliates from *Bos Indicus* Linn—I The Genus *Entodinium* Stein *Univ Calif Publ Zool*, XXXIII, pp 466–544, pls xlix–lii, 17 text figs

†—— (1932)—Do—II A Revision of *Diplodinium* Schuberg *Univ Calif Publ Zool*, XXXVII, pp 53–152, pls iv–vii, 10 text-figs

†—— (1933)—Do—III *Epidinium* Crawley, *Epiplastron* gen nov, and *Ophryoscolex* Stein *Univ Calif Publ Zool*, XXXIX, pp 1–34, 1 pl., 5 text figs

KONSULOFF, ST (1922)—Untersuchungen uber *Opalina* *Arch Protistenk*, XLIV, pp 285–345, pls xii & xiii, 6 text figs

—— (1930)—Haben die Opaliniden zwei Kenarten wie die anderen Infusorien? *Arch Protistenk*, LXXI, pp 248–254, 1 pl

KOSTER, W (1933)—Untersuchungen über Teilung und Conjugation bei *Paramæcium multi-micronucleatum* *Arch Protistenk*, LXXX, pp. 410–33, 33 figs

KUDO, R R (1931)—Handbook of Protozoology London Pp 1–451

KUKENTHAL, W, & KRUMBACH, T (1923)—Handbuch der Zoologie Protozoa I, Lief i–ii, pp 1–292, 287 figs

LACHMANN, J (1856)—Ueber die Organisation der Infusorien, besonders der Vorticellen *Archiv für Anat u Physiol* (Müller), pp 340–98 or *Ann Mag Nat Hist*, XIX, (1857) pp 113–28, 215–41

LAMARCK, J B (1815–16)—Histoire naturelle des Animaux sans vertèbres présentant les caractères généraux et particulièrs de ces Animaux, leur distribution, etc Paris, 2 vols

LANDIS, E M (1920)—An amicronucleate race of *Paramœcium caudatum* *Amer Nat*, LIV, pp 453–7

—— (1925)—Conjugation of *Paramœcium multimicronucleatum* Powers & Mitchell *J Morph* XL, pp 111–67

LANG, A (1913)—Handbuch der Morphologie der Wirbellosen Thiere, Bd 1, pp 1–416 Jena

LANKESTER, E RAY (1870)—Remarks on *Opalina* and its contractile vesicles etc *Quart J Micr Sci*, X, pp 143–50

LAPAGE, C, & WADSWORTH, J F (1916)—*Dendrocometes paradoxus* (Stein)—Part II Reproduction (Bud-formation) *Quart J Micr Sci*, LXI, pp 337–82

LARSON, M E (1928)—Reaction of Opalinas to various laboratory culture media *Trans Amer Micr Soc*, XLVII, pp 1–10

LAUTERBORN, R (1894 *a*).—Ueber die Winterfauna einiger Gowasser der Oberrheinebene Mit Beschreibungen neuer Protozoen *Biol Zbl*, XIV, pp 390–8

—— (1894 *b*)—Beiträge zur Susswasserfauna der Insel Helgoland, Wissenschaftl Meeresunters, herausg v d Commission z Untersuch d deutsch Meere in Kiel, u d biolog Anstalt auf Helgoland, N F, I, pp 217–21

LEBEDOW W (1909)—Über *Trachelocerca phœnicopterus* Cohn Ein marines Infusor *Arch Protistenk*, XIII, pp 70–114, pls vii & viii & 7 text figs

LEDERMULLER, M F (1760)—Mikroskopische Gemuth- und Augen-Ergotzung Nurnberg

LEEUWENHOEK, A v (1677)—Observations concerning little animals by him observed in Rain-, Well-, Sea- and Snow-water, as also in water wherein pepper had lain infused (Cilia, *Vorticella* and ? *Stylonichia*) *Philos Trans*, XII, Nos 133, 134, pp 821–31 and 844–6

—— (1682)—*Giardia* (=*Lamblia*) *Phil Collections*, No 4

—— (1683)—*Opalina* *Philos. Trans*, XIII, No 152.

—— (1687)—Anatomia s interiora rer cum animat t inanimar ope et benefic exquis micr det 1687 Auch in Opera omn s arcana natur Lugd Bat 1722 Pars I, pp 56–7 (Froschparasiten) Pars II, pp 28–31 (Thierchen in Blute der Reben), p 38 (Thierchen in seinen Excrementen)

—— (1703)—*Vorticella* and *Carchesium* *Philos Trans*, XXIII, No 283

LÉGER, L, & DUBOSC, O (1904)—Notes sur les Infusoires endoparasites *Arch Zool exp gén*, (4) II, pp xcviii–c, pp 337–356, pl xiv

—— (1909)—Protozoaires parasites de l'intestin du homard *C R Acad Sci Paris*, CXLVIII, pp 363–5

LEIDY, J (1849)—On the existence of Entophyta in healthy animals as a natural condition *Proc Acad Nat Sci Philad*, IV, p 233

—— (1850 *a*)—Two new species of infusorial Entozoa *Proc Acad Nat Sci Philad*, V, p 100

—— (1850 *b*)—*Nyctotherus*, a new genus of Polvgastrica allied to *Plœsconia* *Ann Mag Nat Hist*, (2) V, p 158

—— (1853)—Some observations on Nematoidea imperfecta and description of three parasitic Infusoria *Trans Amer Phil Soc*, (N S) X, pp 241–4, pl xi

—— (1877)—Remarks on some parasitic Infusoria *Proc Acad Nat Sci Philad*, pp 259–60

de Leon, W (1919)—*Balantidium haughwouti*, new species, parasitic in the intestinal tract of *Ampullaria* sp, a morphological study *Philipp J Sci*, XV, pp 389–409, 1 pl

Lepsi, J (1925)—Über drei marine Enchelinen *Mikrokosmos*, XVIII, pp 146–50

—— (1926 *a*)—Die Infusorien des Süsswassers und Meeres Berlin Pp 1–100, 14 pls, 15 text figs

—— (1926 *b*)—Zur Kenntnis einiger Holotrichen *Arch Protistenk*, LIII, pp 378–406, 14 figs

—— (1928)—Un nouveau protozoaire marin, *Gastrocirrus intermedius* *Ann Protistologie Paris*, I, pp 195–7, 1 fig

—— (1929)—Zur Phylogenie der Ciliaten *Buletinul Facultătii de Stiinte din Cernauti*, III, Heft 2, pp 258–303, 8 diagrams

Lepszy, J (1923)—Über einen neuen Fall von Pseudopodienbildung bei Ciliaten und zwei freischwimmende Vorticellinen *Arch Protistenk*, XLVII, pp 55–8, 3 figs

Leuckart, R (1861)—Ueber *Paramecium* (?) *coli* *Wiegmann's Archiv*, Bd XXVII

—— (1863)—Die Menschlichen Parasiten, und die von ihnen her ruhrenden Krankheiten Bd I Leipzig und Heidelberg

—— (1879)—Die Parasiten des Menschen und die von ihnen herruhrenden den Krankheiten Aufl II Leipzig

Lewin, K R (1911)—The behaviour of the Infusorian micronucleus in regeneration *Proc Roy Soc*, B, LXXXIV, pp 332–44

Lieberkuhn, N (1856)—Beiträge zur Anatomie der Infusorien *Arch Anat Physiol Lpz*, pp 20–36 (Also in *Ann Mag nat Hist*, (II), p 18)

Lieberman, P R (1929)—Ciliary arrangement in different species of *Paramœcium* *Trans Amer Micr Soc*, XLVIII, pp 1–11, 2 pls

Liebetanz, E (1910)—Die Parasitischen Protozoen des Wiederkauermagens *Arch Protistenk*, XIX, pp 19–80, pls i & ii, 1 text fig

Linné, C de (1766–8)—Systema naturæ, 13th edition

Loewenthal, W (1904)—Das Auftreten eines micronucleusartigen Gebildes bei *Opalina ranarum* *Arch Protistenk*, III, pp 387–90, 10 figs

—— (1909)—Notizen uber *Opalina ranarum* nebst Bemerkungen über die Unterschidung von Erythro- und Cyanochromatin *Arch Protistenk*, XIII, pp 115–20, 1 fig

Lucas, C L T (1928)—A study of excystation in *Nyctotherus ovalis*, with notes on other intestinal protozoa of the cockroach *J Parasit*, XIV, pp 161–75, pl vi, 1 text fig

Lucas, M S (1934)—Ciliates from Bermuda sea urchins—I *Metopus* *J R Micr Soc*, LIV, pp 79–93, 4 pls, 1 text fig

Ludwig, W (1930)—Zur Nomenklatur und Systematik der Gattung *Paramecium* *Zool Anz*, XCII, pp 33–41, 1 fig

Luhe, M (1913)—Handbuch der Morphologie der Wirbellosen Tiere Bd 1, pp 1–416, 391 figs Jena

Lund, E E (1933)—A correlation of the silver-line and neuromotor systems of *Paramecium* *Univ Calif Publ Zool*, XXXVIII, pp 35–76, 6 pls, 1 text-fig

Lynch, J E (1929)—Studies on the ciliates from the intestine of *Strongylocentrotus*—I *Entorhipidium* gen nov *Univ Calif Publ Zool*, XXXIII, pp 27–56, 3 pls, 2 text figs

—— (1930)—Do—II *Lechriopyla mystax*, gen nov, sp nov *Univ Calif Publ Zool*, XXXIII, pp 307–50, 3 pls, 2 text-figs

Macdonald, J D (1922)—On *Balantidium coli* (Malmsten) and *Balantidium suis* (sp nov), with an account of their neuromotor apparatus *Univ Calif Publ Zool*, XX, pp 243–300, pls xxvii & xxxiii

MacDougall, M S (1925)—Cytological observations on gymnostomatous Ciliates, with a description of the maturation phenomena in diploid and tetraploid forms of *Chilodon uncinatus* *Quart J Micr Sci*, LXIX, pp 361–84, pls xxiii–xxxiii

—— (1929)—The conjugation of a triploid *Chilodon* *Quart J Micr Sci*, LXXIII, pp 215–23, 16 figs

—— (1935)—Cytological studies of the Genus *Chilodonella* Strand, 1926 (*Chilodon* Ehrbg, 1838)—I The Conjugation of *Chilodonella* sp *Arch Protistenk*, LXXXIV, pp 199–206, 22 figs

Mackinnon, D L, & Adam, D I (1924)—Notes on four Astomatous Ciliates from Oligochæte worms *Quart J Micr Sci*, LXVIII, pp 211–28, pl ix

—— & Ray, H N (1931)—Notes on the Ciliate *Boveria stevensi* Issel from *Galeomma turtoni* Sowerby at Plymouth *J Mar Biol Ass Plymouth*, XVII, pp 577–82, 2 figs

MacLennan, R F (1933)—The pulsatory cycle of the contractile vacuoles in the Ophryoscolecidæ, ciliates from the stomach of cattle *Univ Calif Publ Zool*, XXXIX, pp 205–50, 4 pls, 6 text-figs

—— & Connell, F H (1931)—The Morphology of *Eupoterion pernix* n gen, n sp, a Holotrichous Ciliate from the Intestine of *Acmæa persona* Eschscholtz *Univ Calif Publ Zool*, XXXVI, pp 141–56, 1 pl, 2 text-figs

†Madhava Rao, H S (1928)—Studies on Soil Protozoa—I Protozoan Fauna of some Mysore soils II The function of Mitochondria in some Soil Protozoa *J Indian Inst Sci*, XI A, pp 111–16, pls i–iv, 117–19, pls i & ii

†—— (1929)—The Golgi apparatus of free-living Protozoa *J Indian Inst Sci*, XII A, pp 73–7, 3 pls

Madsen, H (1931)—Bemerkungen über einige entozoische und freilebende marine Infusorien der Gattungen *Uronema*, *Cyclidium*, *Cristigera*, *Aspidisca* und *Entodiscus* gen n *Zool Anz*, XCVI, pp 99–112, 11 figs

Maier, H N (1903)—Über den feineren Bau der Wimperapparate der Infusorien *Arch Protistenk*, II, pp 73–179, pls iii & iv

Malmsten, P H (1857)—Ueber *Paramæcium coli* *Virchows Arch Berlin*, Bd XII, pp 302–9

Mansfeld, K (1923)—16 neue oder wenig bekannte marine Infusorien *Arch Protistenk*, XLVI, pp 97–140, 16 figs

Manson, P, & Sambon, L W (1909)—A case of intestinal pseudoparasitism due to *Chilodon uncinatus* (Blochmann) *Lancet*, I, pp 832–4

Manwell, R D (1928)—Conjugation, division and encystment in *Pleurotricha lanceolata* *Biol Bull Wood's Hole*, LIV, pp 417–63, pls i–xii

MARGOLIN, S (1930)—Methods for the cultivation of cattle ciliates. *Biol Bull Wood's Hole*, LIX, pp 301–5

MARTIN, C H (1909)—Some observations on Acinetaria *Quart J Micr Sci*, LIII, pp 351–89, pls vii & viii, pp 629–64, pl xv

MAST, S O (1917)—Conjugation and encystment in *Didinium nasutum*, with special reference to their significance *J Exp Zool*, XXIII, pp 335–59, tables

—— & LESHLEY, K S (1916)—Observations on ciliary current in free swimming *Paramœcia* *J Exp Zool*, XXI, pp 281–93

—— & NADLER, J E (1926)—Reversal of ciliary action in *Paramecium caudatum* *J Morph*, XLIII, pp 105–17

MATTES, O (1927)—*Anoplophrya ctenodrili* nov spez, ein Ciliat aus dem Darm von *Ctenodrilus monostylus* Zepp *Zool Anz*, LXX, pp 253–62, 9 figs

MAUPAS, E (1879)—*Haptophrya gigantea* etc *C R Acad Sci Paris*, LXXXVIII, pp 921–3

—— (1881)—Contribution a l'etude des Acinetiens *Arch Zool exp gén*, IX, pp 299368, pls xix & xx

—— (1883)—Contribution a l'étude morphologique et anatomique des infusoires cilies *Arch Zool exp gen*, (2) I, pp 427–664

—— (1885)—Sur *Coleps hirtus* *Arch Zool exp gen*, (2) III, pp 337–67

—— (1886 *a*)—Sur la conjugation des infusoires ciliés *C R Acad Sci Paris*, CII, pp 1569–72

—— (1886 *b*)—Sur la conjugation de Paramecies *C R Acad Sci Paris*, CIII, pp 482–4

—— (1886 *c*)—Sur la multiplication de la *Leucophrys patula* *C R Acad Sci Paris*, CIII, pp 1270–3

—— (1888 *a*)—Recherches experimentales sur la multiplication des infusoires cilies *Arch Zool exp gen*, IV, pp 165–277

—— (1888 *b*)—Sur la conjugasion des Vorticellides *C R Acad Sci Paris*, CVI, pp 1607–10 (Abstract in *J R Micr Soc*, 1888, p 752)

—— (1889)—Le rejeunissement karyogamique chez les Cilies *Arch Zool exp gén*, (2) VII, pp 149–517, 7 pls

McCOY, O R (1932)—A culture medium for *Paramœcium* *Science*, LXXV, p 364

McNALLY, E (1926)—Life cycle of *Nassula ornata* and *Nassula elegans* are these species valid? *Biol Bull Wood's Hole*, LI, pp 237–44, pl i

MECZNIKOW, E (1864)—Ueber die Gattung *Sphærophrya* Reichert u Du Bois-Reymond's *Archiv*, pp 258–61, pl 7 A

†MELLO, F DE (1930)—Infusoires parasites de *Rhacophorus maculatus* Gray *Arch Esc Med-Cirurg Nova Goa*, (A) VI, pp 951–7, 1 pl

†—— (1931 *a*)—Do *C R Soc Biol Paris*, CVI, pp 1184–5

†—— (1931 *b*)—Do *Arch zool Torino*, XVI, pp 1440–6, pl xxxviii

†—— (1932)—Contribution à l'étude des Infusoires Parasites des Anoures du Malabar *Rec Indian Mus*, XXXIV, pp 89–124, pls xii–xiv

†—— CARVALHO, J L, & GAITONDO, P (1934)—Cytological studies on *Nyctotherus ovalis*, with special reference to its morphological types *Proc Indian Acad Sci*, I, pp 249–57

Mereschkowsky, K S (1882)—Les Suctociliés, nouv groupe des Infusoires *C R Acad Sci Paris*, XCV, pp 1232–4

—— (1883)—Sur les infusoires suctociliés *C R Acad Sci Paris*, XCVI, pp 276–9

Mermod, G (1914)—Recherches sur la faune infusorienne des tourbières et des eaux voisines de Sainte Croix (Jura vaudois). *Rev suisse Zool*, XXII, pp 31–114, pls ii–iii

Metcalf, M M (1907)—The Excretory Organs of *Opalina* *Arch Protistenk*, X, pp 183–7, pl iv, pp 365–74, 15 figs

—— (1909)—*Opalina* Its Anatomy and Reproduction, with a Description of Infection Experiments and Chronological Review of Literature *Arch Protistenk*, XIII, pp 195–375, pls xiv–xxviii & 17 figs

—— (1918)—*Opalina* and the Origin of Ciliate Infusoria *Journ Wash Acad Sci*, VIII, No 13

—— (1920)—Classification of Opalinidæ *Science*, LII, pp 135–6

—— (1923)—Opalinid ciliate Infusorians *Bull U S Nat Mus*, CXX, pp 1–484

——(1927 *a*)—The bell toads and their Opalinid parasites *Amer Nat*, LXII, pp 5–21, 3 figs

—— (1927 *b*)—"*Opalina elongata*" Gourv is *Cepedea saharana* Metcalf *Science*, LXVI, p 170

——(1929)—Parasites and the aid they give in problems of Taxonomy, Geographical Distribution and Paleogeography *Smithson misc Coll*, LXXXI, pp 1–36, 3 figs

Michelson, E (1928)—Existenzbedingungen und Cystenbildung bei *Paramæcium caudatum* Ehrbg *Arch Protistenk*, LXI, pp 167–84, pls v–vi

Minchin, E A (1912)—An Introduction to the Study of the Protozoa London Pp 1–517

†Mitchell, J (1862)—Notes from Madras *Quart J Micr Sci* n s, II, pp 60–2

Mitter, J (1891)—Beitrag zur Kenntniss des *Balantidium coli* im menschlichen Darmkanale Kiel Gnekow, 41 pp, 1 pl

Miyashita, Y (1928)—On a new parasitic ciliate *Lada tanishi* n sp, with preliminary notes on its heterogamic copulation *Japan J Zool*, I, pp 205–18, pls iv–v, 7 text figs

—— (1929)—Ueber eine primitive Form von Infusoria Astomata, *Protoanoplophrya stomata* gen n, sp n *Annot zool jap*, XII, 1929, pp 289–93, 2 text figs (Abstract in *Japan J Zool*, III, 1930, p (68))

—— (1933 *a*)—Drei neue parasitische Infusorien aus dem Darme einer Japanischen Süsswasseroligochæte *Annot zool jap*, XIV, pp 127–31, 4 figs

—— (1933 *b*)—Studies on a fresh-water Fœttingeriid ciliate, *Hyalospira caridinæ* n g, n sp *Japan J Zool*, IV, p 439, 15 figs.

Mjassnikowa, M (1930 *a*)—*Sphenophrya sphærii* ein neues Infusorium aus *Sphærium corneum* L *Arch Protistenk*, LXXI, pp 255–94, 2 pls, 14 text figs

—— (1930 *b*)—Über einen neuen Vertreter der Familie Sphenophryidæ aus *Mya truncata* L *Arch Protistenk*, LXXII, pp 377–89, 1 pl

Moody, J E (1913)—Observations on the life history of two rare ciliates, *Spathidium spathula* and *Actinobolus radians* *J. Morph*, XXIII, pp 349–407

MOORE, E L (1924 *a*)—Regeneration at various phases in the life history of *Spathidium spathula* and *Blepharisma undulans* *J Exp Zool*, XXXIX, pp 249–316

—— (1924 *b*)—Endomixis and encystment in *Spathidium spathula*, *J Exp Zool*, XXXIX, pp 317–77

—— (1924 *c*)—A further study of the effects of conjugation and encystment in *Spathidium spathula* *J, Exp Zool*, XL, pp 217–30

MOORE, J (1934)—Morphology of the contractile vacuole and cloacal region in *Blepharisma undulans* *J Exp Zool*, LXIX, pp 59–104, 15 figs

MORGAN, W DE (1924)—*Fœttingeria actiniarum* (parasitic in Anemones) *Quart J Micr Sci*, LXVIII, pp 343–60, pl xi

MOZLEY, A (1932)—A biological study of a temporary pond in Western Canada *Amer Nat*, LXVI, pp 235–49

MUDREZOWA-WISS, K (1929)—Eine neue Form der Infusoria aspirotricha, "*Triloba paradoxa*" nov gen, nov sp *Arch Protistenk*, LXVIII, pp 422–6, 6 figs

MULLER, O F (1773)—Verminum terrest et fluviatil s animal infusor etc historia Hafniæ et Lipsiæ, Parts I & II

—— (1777)—Zoologiee danicæ s animal Daniæ et Norvegiæ rac ac minus notor icones Hafniæ

—— (1786)—Animalc infusoria, fluviat et marina etc Hafniæ et Lipsiæ

MULSOW, W (1913)—Die Conjugation von *Stentor cœruleus* und *Stentor polymorphus* *Arch Protistenk*, XXVIII, pp 363–88, pls xix–xxii

NAGAHANA, M (1932 *a*)—On the morphology and cultivation of *Balantidium* found in *Mus norvegicus* Erxl (In Japanese) *Chosen Ig Kw Z*, XXII, No 4, pp 355–68 (English Abstract in *Japan J Zool*, V, 1933, p (21))

—— (1932 *b*)—On the cultivation of *Balantidium coli* (In Japanese) *Chosen Ig Kw Z*, XXII, No 4, pp 369–77 (English Abstract in *Japan J Zool*, V, 1933, p (21))

—— (1932 *c*)—The morphology and culture of a *Balantidium* found in the wild rat (*Mus norvegicus* Erxl) *Keijo J Med*, III, pp 492–500, 2 pls

NAGLER, K (1911)—Caryosom und Centriol beim Teilungavorgang von *Chilodon uncinatus* *Arch Protistenk*, XXIV, pp 142–8, pl xi

NASSANOV, D (1924)—Der Excretionsapparat (Kontractile Vakuole) der Protozoen als Homologon des Golgischen Apparats der Metazoenzell *Arch mikr Anat*, CIII, pp 437–80, pls i–iii

NELSON, E C (1932)—The cultivation of a species of *Troglodytella*, a large ciliate, from the chimpanzee *Science*, LXXV, pp 317–18

—— (1933)—The feeding reactions of *Balantidium coli* from the chimpanzee and pig *Amer J Hyg*, XVIII, pp 185–201, 1 pl

—— (1934)—Observations and experiments on conjugation of the *Balantidium* from the chimpanzee *Amer J Hyg*, XX, pp 106–34, 1 pl

—— (1935)—Cultivation and cross infection experiments with Balantidia from Pig, Chimpanzee, Guinea Pig and *Macacus rhesus* *Amer J Hyg*, XXII, pp 26–43

Nereshemer, E (1903)—Über die Hohe histologischer Differenzierung bei heterotrichen Ciliaten *Arch Protistenk*, II, pp 305–24, pl vii & 1 fig

—— (1907 *a*)—Nochmals uber *Stentor cœruleus* *Arch Protistenk*, IX, pp 137–8

—— (1907 *b*)—Die Fortpflanzung der Opalinen *Arch Protistenk*, Suppl I, pp 1–42, pls i–iii & 2 text figs

Nitzch, C L (1817)—Beitrage zur Infusorienkunde *Neue Schrift d naturf Ges in Halle*, III, p 3

—— (1827)—Allgemeine Encyclopädie der Wissenschaften und Kunste, XVI Leipzig

Noble, A E (1929)—Two new species of the protozoen genus *Ephelota* from Monterey Bay *Univ Calif Publ Zool*, XXXIII, pp 13–26, 2 pls, 3 text figs

—— (1932)—On *Tokophrya lemnarum* Stein (Suctoria), with an account of its budding and conjugation *Univ Calif Publ Zool*, XXVII, pp 477–506, 7 pls

Noc, F (1908)—Un cas de dysenterie a *Balantidium* chez le *Macacus cynomolgus* *C R Soc Biol Paris*, LXIV, pp 878–80

Noland, L E (1925 *a*)—A review of the genus *Coleps*, with description of two new species *Trans Amer Micr Soc*, XLIV, pp 3–13, pl i

—— (1925 *b*)—Factors influencing the distribution of Fresh water ciliates *Ecology*, VI, pp 437–52

—— (1927)—Conjugation in the ciliate *Metopus sigmoides* C & L *J Morph*, XLIV, pp 341–62, pls i–vi

—— & Finley, H E (1931)—Studies on the taxonomy of the genus *Vorticella* *Trans Amer Micr Soc*, L, pp 81–123, pls viii–xi

Noller, W (1926)—Balantidien und Balantidiosis Tierheilkunde und Tierzucht von Valentin Stang u David Wirth, pp 88–95, 3 figs

—— (1927)—Protozoen Enzyklopadie der mikroskopischen Technik, Bd III

Oehler, R (1919)—Flagellaten und Ciliatenzucht auf reinem Boden *Arch Protistenk*, XL, pp 16–26

—— (1920)—Gereinigte Ciliatenzucht *Arch Protistenk*, XLI, pp 34–49

—— (1924 *a*)—Weitere Mitteilungen uber gereinigte Amoben und Ciliatenzucht *Arch Protistenk*, XLIX, pp 112–34

—— (1924 *b*)—Gereinigte Zucht von freilebenden Amoben, Flagellaten und Ciliaten (Sammelbericht fruherer Arbeiten) *Arch Protestenk*, XLIX, pp 287–96

Oken, L (1815)—Lehrbuch der Naturgeschichte, III (I) Weimar

Ostroumow, W (1929)—Ueber den Bau und Biologie von *Nyctotherus ovalis* Leidy *Arch russes Protist*, VIII, pp 24–50, 2 pls, 13 text-figs

Overbeck de Mayer, G A W van (1929)—Beiträge zu wachstums- und Plasmadifferenzierungs-Erscheinungen an *Opalina ranarum* *Arch Protistenk*, LXVI, pp 207–84, 43 figs

Pack, D A (1919)—Two Ciliates of Great Salt Lake *Biol Bull Wood's Hole*, XXXVI, pp 273–82

Parker, A J (1883)—Reproduction of *Amphileptus fasciole* *Ann. Mag Nat Hist*, (5) XIII, p 416

Parker, R C. (1926)—Symbiosis in *Paramecium bursaria* J Exp Zool, XLVI, pp 1–12

Parpart, A K (1928)—The bacteriological sterilization of *Paramecium* Biol Bull Wood's Hole, LV, pp 113–20

Patten, R (1932 *a*)—Cytoplasmic inclusions of *Opalina* and *Nyctotherus* Nature, CXXX, pp 311–12

—— (1932 *b*)—Observations on the cytology of *Opalina ranarum* and *Nyctotherus cordiformis* Proc R Irish Acad, XLI, pp 73–94, 2 pls, 13 text figs

Penard, E (1914)—Sur quelques Tentaculifères muscicoles Arch Protistenk, XXXIV, pp 277–94, 19 figs

—— (1917)—Le genre *Loxodes* Rev suisse Zool, XXV, pp 453–89

—— (1918 *a*)—A new type of Infusorian *Arachnidiopsis paradoxa* J R Micr Soc, pp 283–9, 1 pl

—— (1918 *b*)—Sur un Tentaculifère peu connu, *Podophrya soliformis* (Lauterborn) Rev suisse Zool, XXVI, pp 1–16

—— (1919)—On *Folliculina boltoni* J R Micr Soc, pp 305–19, pls i & ii

—— (1920 *a*)—Observations sur les Infusoires Tentaculifères Mém Soc phys Genève, XXXIX, pp 131–229

—— (1920 *b*)—Observations sur le *Strombidium viride* Stein Rev suisse Zool, XXVIII, pp 1–19

—— (1922)—Études sur les Infusoires dieau douce Genève Pp 1–331

Penn, A B K-C (1932)—A method for culturing *Bursaria truncatella* Anat Rec, LIV, Suppl, p 99

—— (1935)—Factors which control Encystment in *Pleurotricha lanceolata* Arch Protistenk, LXXXIV, pp 101–32

Percy, M (1929)—*Physophaga sappheira*, n g, n sp Quart J Micr Sci, LXXIII, pp 107–20, 1 pl

Perty, M (1852)—Zur Kenntniss kleinster Lebensformen Bern

Pertzewa, T A (1929)—Zur Morphologie von *Plagiotoma lumbrici* Duj Arch Protistenk, LXV, pp 330–63, pl xiii & 43 text-figs

Peschkoff, M (1929)—Beiträge zur Kenntniss der Biologie und Morphologie der *Bursaria truncatella* O F Mull, sowie ihres Kernapparates wahrend der Teilung Arch Russes Protist, VIII, pp 1–16, 1 pl, 5 text figs

Peschkowsky, L (1927)—Skelettgebilde bei Infusorien Arch Protistenk, LVII, pp 31–57, 5 figs

—— (1928)—On the biology and morphology of *Climacostomum virens* Arch Russes Protist, VII, pp 205–34, 1 pl, 10 text figs

—— (1931)—Zur Morphologie von *Dileptus gigas* und *Loxophyllum meleagris* Arch Protistenk, LXXV, pp 179–202, pl xiv, 9 text-figs

Pestel, B (1931)—Beiträge zur Morphologie und Biologie des *Dendrocometes paradoxus* Stein Arch Protistenk, LXXV, pp 404–71, 55 figs

Phillips, F W (1882)—On a new Ciliate Infusorian allied to *Pleuronema* (*Calyptotricha* n g) J Linn Soc Zool, XVI, pp 476–8

PHILLIPS, R L (1922)—The growth of *Paramecium* in infusions of known bacterial content *J Exp Zool*, XXXVI, pp. 135–83 1 fig

PHILPOT, C H (1928)—Growth of Paramecia in pure cultures of pathogenic bacteria and in the presence of soluble products of such bacteria *J Morph*, XLVI, pp 85–129, 6 charts

PIERANTONI, U (1909)—Struttura, biologica e sistematica di *Anoplophrya paranaidis* n sp *Arch Protistenk*, XVI, pp 81–106 pls v & vi

PINTO, C (1926 *a*)—*Nyctotherus* dos blattideos do Brasil *Bol biol Fac Med S Paulo*, I, pp 14–16, 1 pl

—— (1926 *b*)—Anatomia e biologia dos *Nyctotherus* dos batrachios do Brazil (*Nyctotherus tejerai* novae specie) *Bol biol Fac Med S Paulo*, III, pp 45–8, 3 figs

PLOUGH, H (1916)—The genus *Aspidisca* Ehrenberg *Trans Amer Micr Soc*, XXXV pp 233–44

POCHE, F (1913)—Das System der Protozoa *Arch Protistenk*, XXX, pp 125-321, 1 fig

POISSON, R (1930)—Observations sur *Anophrys sarcophaga* Cohn (=*A maggii* Cattaneo) Infusoire holotriche marin et sur son parasitisme possible chez certain Crustacés *Bull Biol France Belg*, LXIV, pp 288–331, 11 figs

POLJANSKY, G (1925)—Drei neue parasitische Infusorien aus dem Parenchym einiger Mollusken und Turbellarien *Arch Protistenk*, LII, pp 381–93, pl xiii

—— (1926)—Die Conjugation von *Dogielella sphærii* (Infusoria, Holotricha, Astomata) *Arch Protistenk*, LIII, pp 407–34, pl xvi, 1 text fig

—— (1928)—Über die Konjugation von *Bursaria truncatella* *Zool Anz*, LXXIX, pp 51–8, 2 figs

—— (1933)—Geschlechtsprozesse bei *Bursaria truncatella* O F Mull *Arch Protistenk*, LXXXI, pp 420–546, 5 pls, 51 figs

POWERS, P B A (1932)—*Cyclotrichium meunieri* sp n cause of red water in the Gulf of Maine *Biol Bull Wood's Hole*, LXIII, pp 74–80, 1 pl

—— (1933)—Studies on the ciliates from sea urchins—I General taxonomy II *Entodiscus borealis* (Hentschel) (Protozoa, Ciliata), behavior and morphology *Biol Bull Wood's Hole*, LXV, pp 106–21, 2 pls, pp 122–36, 2 pls, 1 text fig

PRANDTL, H (1906)—Die Konjugation von *Didinium nasutum* O F M *Arch Protistenk*, VII, pp 229–58, pls ix & x & 12 figs

PRECHT, H (1935)—Die Struktur des Stiéles bei den *Sessilia* *Arch Protistenk*, LXXXV, pp 234–50, 5 figs

PRINGSHEIM, E G (1915)—Die Kultur von *Paramæcium bursaria* *Biol Zbl*, XXXV, pp 375–9

—— (1925)—Über *Paramecium bursaria* Ein Beitrag zur Symbiose Frage *Lotos*, LXXIII, pp 135–88

—— (1928)—Physiologische Untersuchungen an *Paramæcium bursaria* Ein Beitrag zur Symbioseforschung *Arch Protistenk*, LXIV, pp 289–418, pls x–xi & 7 figs

PRITCHARD, A (1861)—A History of Infusoria London

PROWAZEK, S v (1904)—Der Encystierungsvorgang bei *Dileptus* *Arch Protistenk*, III, pp 64–8, 9 figs

PROWAZEK, S v (1913 *a*)—Studien zur Biologie der Protozoen—VI. *Arch Protistenk*, XXXI, pp 47–71, pl v

—— (1913 *b*)—Zur Kenntniss der Balantidiosis Zusammenfassende Darstellung *Arch Schiffs u Tropenhyg*, XVII, pp 1–24, 2 pls

—— (1915)—Zur Morphologie und Biologie von *Colpidium colpoda* *Arch Protistenk*, XXXVI, pp 72–80, 14 figs

—— (1916)—Zur Konjugation von *Loxocephalus* Aus dem Nachlass von S v Prowazek herausgegeben von Kurt Behrend *Arch Protistenk*, XXXVII, pp 1–5, pl i

—— & JOLLOS, V (1921)—Taschenbuch der mikroskopischen Technik der Protistenuntersuchung Dritte Auflage Leipzig Pp 1–96

PRUTHI, H S (1926)—On the hydrogen-ion concentration of hay infusions, with special reference to its influence on the protozoan sequence *Brit J Exp Biol*, IV, pp 292–300, 1 fig

PURKINJE J E, & VALENTIN, G (1835)—De phænomeno generali et fundamentali Motûs vibratorii continui in Membranis, cum externis tum internis, Animalum plurimorum obvii Bratislaviæ

PUSCHKAREW, B M (1913)—Über die Verbreitung der Susswasser protozoen durch die Luft *Arch Protistenk*, XXVIII, pp 323–62, pls xvii–xviii

QUENNERSTEDT, A (1865)—Bidrag til sveriges Infusorienfauna *Acta Univ lund*, II, pp 1–64, 2 pls

—— (1867)—Bidrag til sveriges Infusorienfauna *Acta Univ lund*, IV, pp 1–47, 2 pls

—— (1869)—Bidrag til sveriges Infusorienfauna *Acta Univ lund*, VI, pp 1–35, 1 pl

RAABE, Z (1932)—Untersuchungen an einigen Arten des Genus *Conchophthirus* Stein *Bull int Acad Cracovie*, B II, pp 295–310, 1 pl, 16 figs

—— (1933 *a*)—*Desmophrya contorta* gen n, sp nov, ein im Darm von *Pisidium* parasitierender Ciliate aus der Familie Hoplitophryidæ Cheissin (Infusoria Astomata) *Ann Mus zool polon*, X, pp 51–6, 2 pls

—— (1933 *b*)—*Protoanoplophrya bithyniæ* sp n, eine neue parasitische Ciliaten-Art aus dem Subordo Astomato *Ann Mus zool polon*, IX, pp 354–8, 1 pl

—— (1934)—Über einige an den Kiemen von *Mytilus edulis* L und *Macoma balthica* (L) parasitierende Ciliaten-Arten *Ann Mus zool polon*, X, pp 289–303, 2 pls, 2 text figs

RAFINESQUE SCHMALTZ, C S (1814)—Specchio delle Scienze I (3) Palermo

†RAY, H (1932)—On the Morphology of *Balantidium sushilii* n sp, from *Rana tigrina* Daud *Journ R Micr Soc*, LII, pp 374–82, 1 pl, 5 text figs

†—— & CHAKRAVARTY, M (1934 *a*)—Studies on the ciliate, *Conchopthirus lamellidens* Ghosh, from the gills of a fresh water mussel *Proc Indian Sci Cong* (Zoology Abstracts), p 1

†—— —— (1934 *b*)—Lunar periodicity in the conjugation of *Conchophthirius lamellidens* Ghosh *Nature*, CXXXIV, p 663

REED, H, & HAUSMAN, L A (1927)—The occurrence of *Opercularia walgreni* Grier in a filtration plant *Trans Amer Micr Soc*, XLVI, pp 149–52, 4 figs

REES, C M (1922)—The micro injection of *Paramœcium* *Univ Calif Publ Zool*, XX, pp 235–42

REES, C W (1921)—The neuromotor apparatus of *Paramœcium* *Amer Nat*, LV, pp 464–8

—— (1922)—The neuromotor apparatus of *Paramœcium* *Univ. Calif Publ Zool*, XX, pp 333–64, pls xxxii–xxxvi

—— (1927)—Balantidia from pigs and guinea pigs their viability, cyst production and cultivation *Science*, LXVI, pp 89–91

—— (1930)—Studies on the morphology and behaviour of *Buxtonella sulcata* from cattle and of *Balantidium coli* from the pig *Parasitology*, XXII, pp 314–25, 1 pl, 6 text figs

REICHENBACH, H G L (1828)—Zoologie, I

REICHENOW, E (1920)—Den Wiederkäuer Infusorien verwandte Formen aus Gorilla und Schimpanse *Arch Protistenk*, XLI, pp 1–33, pls i–ii, 3 text-figs

—— (1929)—Lehrbuch der Protozoeenkunde Funfte Auflage Jena Pp 1–1262

—— (1932)—Protozoa (in Brohmer's Fauna von Deutschland, Leipzig), pp 1–26, 131 figs

RENKAUF, E (1930)—Zur Biologie von *Didinium nasutum* Stein *Z vergl Physiol*, XI, pp 689–701, 3 pls, 10 text-figs

REYNOLDS, M E C (1932)—Regeneration in an amicronucleate infusorian *J Exp Zool*, LXII, pp 327–61, 5 figs

RHUMBLER (1888)—Die verschiedenen Cystenbildungen und die Entwicklungsgeschichte der holotrichen Infusoriengattung *Colpoda* *Z wiss Zool*, XLVI, pp 549–601

ROOT, F M (1914)—Reproductions and reactions to food in the Suctorian *Podophrya collini* n sp *Arch Protistenk*, XXXV, pp 164–96, 11 figs

—— (1922)—A new Suctorian from Wood's Hole *Trans Amer Micros Soc*, XLI, pp 77–81, 1 pl

ROSSOLIMO, L L (1926 *a*)—Parasitische Infusorien aus dem Baikal-See *Arch Protistenk*, LIV, pp 468–509, pls xxvi–xxvii, 1 text fig

—— (1926 *b*) Über einiger neue und wenig bekannte Infusoria Astomata aus dem Anneliden des Russischen Nordens *Zool Anz*, LXVIII, pp 52–57, 7 figs

—— (1927)—On some new and little known infusoria Astomata from the Annelides of the north of Russia *Proc 2nd Congress Zool Anat Histol U S S R*, pp 293–5

—— (1928)—Über einige neue und wenig bekannte Infusoria-Astomata aus den Anneliden des Russichen Nordes *Ber wiss Meeres inst*, III, pp 83–95, 1 pl

—— (1929)—Über *Spirofilum tisiæ* Gelei und *Hypotrichidium conicum* Ilowaisky *Zool Anz*, LXXXVI, pp 69–74, 3 figs

—— & JAKIMOWITSCH, K (1929)—Die Kernteilung bei *Conchophthirius Stensetrupii* St *Zool Anz*, LXXXIV, pp 323–33, 13 figs

—— & PERLEWA, T A (1929)—Zur Kenntnis einiger astomen Infusorien Studien au Skelettbildung *Arch Protistenk*, LXVII, pp 237–52, 17 figs

ROUX, J (1901)—Faune Infusorienne des eux stagnantes des environs des Genève Genève Pp 1–148, 8 pls

RUHMEKORF, T (1935)—Morphologie, Teilung, und Hungerformen von *Keronopsis* *Arch Protistenk*, LXXXV, pp 255–88, 15 figs & 2 graphs

RUSSO, A (1930) —Ciclo evolutivo di " *Cryptochilum echini* " Maupas (Ciliata parassita del *Paracentrotus lividus* (Mrtsn)) *Mem Accad Lincei*, (6) IV, pp 167–249, 8 pls, 30 text figs

SAEDELEER, H DE, & TELLIER, L (1929) —*Heliophrya collini* gen n sp n Acinetien d'eau douce *Ann Soc zool Belg*, LX pp 12–15, 5 figs

SAHRHAGE, H (1916) —Über die Organisation und den Teilungsvorgang des Flaschentierchens (*Folliculina ampulla*) *Arch Protistenk*, XXXVII, pp 139–74, pls x & xi

SAMUELSON, J (1857) —*Glaucoma scintillans* *Quart J Micros Sci*, V, pp 18–19

SAND, R (1901) —Étude monographique sur le groupe des Infusoires Tentaculiferes Brussels Pp 1–441, pls i–xxiv Also in *Ann Soc Belge Micr*, XXIV, XXV, XXVI

†SANDON, H (1927) —The composition and distribution of the protozoan fauna of the soil Edinburgh Pp xiii+237, pls i–vi, 2 text figs, 3 charts

SASSUCHIN, D N (1928 *a*) —Zur Frage uber die Parasiten der Protozoen Parisiten von *Nyctotherus ovalis* Leidy *Arch Protistenk*, LXIV, pp 61–70, pls iii & iv, 3 text figs

—— (1928 *b*) —Zur Frage uber die ecto- und entoparasitischen Protozoen der Froschkaul quappen *Arch Protistenk*, LXIV, pp 71–92, pls v–viii, 2 text figs

SAUERBREY, E (1928) —Beobachtungen uber einige neue oder wenig bekannte marine Ciliaten *Arch Protistenk*, LXII, pp 355–407, pls xxii–xxvi

SCHEWIAKOFF, W (1889) —Beiträge zur Kenntniss der holotrichen Ciliaten Biblioth Zoolog (Leuckart u Chun), Hft 5, pp 1–77

—— (1893) —Ueber die geographische Verbreitung der Susswasser Protozoen *Mém Acad Sci de St Pétersb*, (7) XLI, pp 1–201

—— (1894) —Ueber die Natur der sogenannten Excretkorner der Infusorien *Z wiss Zool*, LVII, pp 32–56

—— (1896) —Infusoria Aspirotricha (Holotricha auctorum) *Mém Acad Sci de St Pétersb*, (8) IV, pp 1–393, pls i–vii

SCHIRCH, P F (1931) —O enquistamento do infusorio *Nyctotherus cordiformis* Ehrb (Encystment of *N cordiformis*) (Portuguese, with German summary) *Bol Mus nac Rio de J*, VII, pp 295–8, 1 pl

SCHLEIP, W (1911) —Anleitung zum praktischen Studium niederer Tiere Berlin Pp 1–154

SCHMAHL, O (1926) —Die Neubildung des Peristoms bei der Teilung von *Bursaria truncatella* *Arch Protistenk*, LIV, pp 359–430, pls xvii–xxii, 24 text figs

SCHMARDA, L (1854) —Zur Naturgeschichte Aegyptens *Denkschr Akad Wiss Wien*, VII, pp 1–28

SCHNEIDER (1886) —Fragments sur les infusoires Tablettes Zoologiques, I, pp 82–7, 4 pls

SCHOENICHEN, W (1927) —Protozoa (Urtiere) Eyferth Schoenichen's Einfachste Lebensformen des Tier- und Pflanzenreiches Funfte Auflage, Berlin II, pp 1–293, text figs 427–823, pls ix–xiii

SCHRANK, F P VON (1803) —Fauna boica, III

SCHRÖDER, O (1906 *a*)—Beiträge zur Kenntnis von *Campanella umbellaria* L sp *Arch Protistenk*, VII, pp 75–105, pls i & ii

—— (1906 *b*)—Beiträge zur Kenntnis von *Epistylis plicatilis* (Ehrbg) *Arch Protistenk*, VII, pp 173–85, pl vi

—— (1906 *c*)—Beiträge zur Kenntnis von *Vorticella monilata* Tatem *Arch Protistenk*, VII, pp 395–410, pl xviii, 2 text-figs

—— (1907)—Beiträge zur Kenntnis von *Stentor cœruleus* Ehrbg und *St roeseli* Ehrbg *Arch Protistenk*, VIII, pp 1–16, 1 pl

SCHUBERG, A (1886).—Ueber den Bau der *Bursaria truncatella* *Morph Jahrb*, XII, pp 333–65, pls xix & xx

—— (1888)—Die Protozoen des Wiederkäuermagens *Zool Jahrb* III, pp 365–418, 2 pls

—— (1891)—Einige Organisationsverhältnisse der Infusorien des Wiederkäuermagens *Sitz Ber phys med Ges Würzburg*, pp 123–37 (Abstract in *J R Micr Soc*, 1892, p 494)

—— (1905)—Über Cilien und Trichocysten einiger Infusorien *Arch Protistenk*, VI, pp 61–110, pls iv & v

SCHUBOTZ, H (1908)—(Ref von E Berliner) *Pycnothrix monocystoides* nov gen, nov sp, ein neues ciliates Infusor aus dem Darm von *Procavia* (Hyrax) *capensis* (Pallas) *Arch Protistenk*, XI, pp 382–4

SCHULZ, E (1931)—Beiträge zur Kenntnis mariner Suctorien *Zool Anz*, XCVI, pp 95–9, 6 figs

SCHULZE, P (1924)—Der Nachweis und die Verbreitung des Chitins mit einem Anhang über das komplizierte Verdauungssystem der Ophryoscoleciden *Z Morph Ökol Tiere*, II, pp 643–66, 13 figs

SCHUMACHER, I C (1915)—On *Blepharocorys equi* sp nov, a new ciliate from the cæcum of the horse *Univ Calif Publ Zool*, XVI, pp 95–106

SCHUMAKER, E (1929)—Experimental infection of rats with the Balantidium from the pig *Science*, LXX, p 384

—— (1931 *a*)—The cultivation of *Balantidium coli* *Amer J Hyg*, XIII, pp 281–95

—— (1931 *b*)—Relation of *Balantidium coli* infection to the diet and intestinal flora of the domestic pig *Amer J Hyg*, XIII, pp 576–84

SCHWARTZ, V (1935)—Versuche über Regeneration und Kerndimorphismus bei *Stentor cœruleus* Ehrbg *Arch Protistenk*, LXXXV, pp 100–39, 26 figs

SCHWEYER, A (1910)—Zur Kenntnis des Tintinnodeenweichkorpers *Arch Protistenk*, XVIII, pp 134–89, pls x & xi, 9 figs

SCOTT, G H, & HORNING, E S (1932)—The structure of Opalinids, as revealed by the technique of micro incineration *J Morph*, LIII, pp 381–8

SCOTT, M J (1927)—Studies on the *Balantidium* from the guinea-pig *J Morph*, XLIV, pp 417–65, pls i–vi, 3 text-figs

SHAPIRO, N N (1927)—The cycle of hydrogen-ion concentration in the food vacuoles of *Paramœcium*, *Vorticella*, and *Stylonychia* *Trans Amer Micr Soc* XLVI, pp 45–53, pl vi

SHARP, R G (1914)—*Diplodinium ecaudatum*, with an account of its neuromotor apparatus *Univ Calif Publ Zool*, XIII, pp 43–122, pls iii–vii, 4 text figs

SIEBOLD, C T E VON (1845)—Lehrbuch d vergleich Anat d wirbellosen Thiere, Hft 1

†SIMMONS, W J (1889)—Note on a species of *Podophrya* found in Calcutta *Amer Mon Micr J*, X, p 145

†—— (1891)—Some of the animal and vegetable micro organisms procurable in the General's Tank, Calcutta *Bull Micr Soc Calcutta*, I pp 1–5

†SINTON, J A (1923)—The occurrence of *Balantidium coli* in the fæces of an Indian *Indian Med Gaz*, LVIII, p 432

SPECHT, H (1935)—The Culture of *Spirostomum ambiguum* *Arch Protistenk*, LXXXV, pp 150–2

SPIEGEL, A (1926)—Einige neue marine Ciliaten *Arch. Protistenk*, LV, pp 184–90, 4 figs

STATKEWITSCH, P (1905)—Zur Methodik der biologischen Untersuchungen über die Protisten *Arch Protistenk*, V, pp 17–39

STEIN, F (1849)—Untersuch über die Entwicklung der Infusorien *Arch Naturgesch*, I, pp 92–148

—— (1851)—Neue Beiträge zur Kenntniss der Entwicklungsgesch und des feineren Baues der Infusionsthiere *Z wiss Zool*, III, pp 479–509

—— (1854)—Die Infusionsthiere auf ihre Entwicklungsgeschichte untersucht Leipzig, pls i–vi

—— (1858)—Ueber mehrere neue im Pansen der Wiederkäuer lebende Infusionsthiere, Ueber die geschlechtliche Fortpflanzung der Infusorien *Abh d K Böhmischen Gesell der Wiss*, X, pp 69–70

—— (1859 *a*)—Charakteristik neuer Infusoriengattungen *Lotos*, IX, pp 2–5 & 57–60

—— (1859 *b*)—Ueber die ihm bie jetzt bekannt gewordenen u v ihm genauer erforschten Infus, welche im Inneren v anderen Thieren eine parasitische Lebensweise fuhren *Abh d K Böhmischen Gesell der Wiss*, X, pp 35–8

—— (1859 *c*)—Ueber die wahrend der vorflossenen Sommerferien in der Ostsee bei Wismar v ihm beob Infus *Abh d K Böhmischen Gesell der Wiss*, X, pp 62–3

—— (1859 *d*)—Der Organismus der Infusionsthiere nach eigenen Forschungen in systemat Reihenfolge bearbeitet—I Abt Die hypotrichen Infusionsthiere Leipzig

—— (1859 *e*)—Einige seiner neuesten Entdeckungen in d Infusorienkunde *Sitz Ber böhm Ges Wiss*, pp 84–6

—— (1860 *a*)—Ueber die Eintheilung der holotrichen Infusionsthiere und einige neuere Gattungen und Arten dieser Ordnung *Sitz Ber böhm Ges Wiss*, pp 56–62

—— (1860 *b*)—Ueber *Leucophrys patula* u über 2 neue Infusoriengattungen *Gyrocoris* und *Lophomonas* *Sitz.Ber böhm Ges Wiss*, pp 44–50

—— (1861)—Ueber ein neues paras Infusor aus d Darmkanal von Paludina *Sitz Ber böhm Ges Wiss*, p 85

—— (1862 *a*)—Kritische Besprechung d Infusorienbehandlung v C Eberhard und A Wrzesniowsky *Sitz Ber böhm Ges Wiss*, pp 50–7

—— (1862 *b*)—Neue oder noch nicht genugend bekannte Infusorienform aus d Ostsee bei Wismar *Amtl Ber der Vers deutsch Naturf u Aerzte zu Karlsbad*, XXXVII, pp 161–2

STEIN, F (1867)—Der Organismus der Infusionsthiere nach eigenen Forschungen in systematischer Reihenfolge bearbeitet—II (Allgemeines u Heterotricha) Leipzig

STEMPELL, W (1914)—Ueber die Funktion der pulsierondon Vacuole *Zool Jahrb Abt allg Zool u Physiol*, XXXIV, pp 437–78

—— (1924)—Weitere Beiträge zur Physiologie der pulsierenden Vakuole von Paramæcium—I Lyotrope und cytotrope Reihen *Arch Protistenk*, XLVIII, pp 342–64, 1 text fig & 1 table

STERKI, V (1878)—Beiträge zur Morphologie der Oxytrichinen *Z wiss Zool*, XXXI, pp 29–58, pl iv

STEVENS, N M (1904)—Further Studies on the Ciliate Infusoria, *Licnophora* and *Boveria* *Arch Protistenk*, III, pp 1–43, pls i–vi

—— (1910)—The Chromosomes and Conjugation in *Boveria subcylindrica* var *concharum* *Arch Protistenk*, XX, pp 126–31, 22 figs

STILES, C W (1893)—Report on a Parasitic Protozoan (Holophrya-*Ichthyophthirius multifiliis*) *Bull U S Fish Comm*, pp 173–189

STILLER, J (1932)—Dimorphismus und Conjugation bei *Epistylis ovum* (*Rhabdostyla ovum*) Kent *Acta biol Szeged*, II, pp 129–34, 5 figs

STIRRUP, H (1913)—A descriptive study of an Oligochæte worm of the Fam *Enchytræidæ* with an Appendix on certain commensal Protozoa *Proc Zool Soc London*, pp 300–21, pls xlvi–xlix

STOKES, A (1884 *a*)—Note on some apparently undescribed forms of fresh-water Infusoria Sillim's *Amer J Sci*, XXVIII, pp 38–49

—— (1884 *b*)—Notices of new fresh-water Infusoria *Amer Mon Micr J*, V, pp 121–5, figs 1–9 (*J R Micr Soc*, (2) IV, pp 245–6)

—— (1884 *c*)—Notes on a new Infusorian (*Ctedoctema acanthocrypta*) *Amer Nat*, XVIII, pp 659–60 (*J R Micr Soc*, (2) IV, pp 905–7)

—— (1884 *d*)—Notes on some apparently undescribed Infusoria from putrid waters *Amer Nat*, XVIII, pp 133–40. (*J R Micr Soc*, (2) IV, p 245)

—— (1884 *e*)—Notices of some new parasitic Infusoria *Amer Nat*, XVIII, pp 1081–6 (*J Micrographie*, pp 566–72)

—— (1885 *a*)—Some new Infusoria *Amer Nat*, XIX, pp 433–43 (*J Micrographie*, X, pp 286–323)

—— (1885 *b*)—Note on some apparently undescribed forms of fresh-water Infusoria Sillim's *Amer J Sci*, XXIX, pp 313–28

—— (1885 *c*)—Notices of new fresh-water Infusoria *Amer Mon Micr J*, VI, pp 121–7, 9 figs

—— (1885 *d*)—Some new Infusoria from American fresh-waters *Ann Mag Nat Hist*, (5) XV, p 437

—— (1886 *a*)—Some new Infusoria from American fresh waters *Ann Mag Nat Hist*, (5) XVII, pp 98–111, 1 pl (*J R Micr Soc*, VI, (2) p ?62)

—— (1886 *b*)—Some new Infusoria, etc *Ann Mag Nat Hist*, (5) XVII, pp 387–8

STOKES, A (1886 c)—Some new Hypotrichous Infusoria *Proc Amer Phil Soc*, XXIII, pp 21–30, 1 pl (*J R Micr Soc*, 1887, p 418)

—— (1886 *d*)—Some new Infusoria of American fresh waters *Ann Mag Nat Hist*, (5) XVII, p 534

—— (1886 *e*)—Notices of new fresh-water Infusoria *Amer Mon Micr J*, VII, pp 81–6, 18 figs (*J R Micr Soc*, VI, (4) pp 633, 634)

—— (1887 *a*)—Notices of American fresh-water Infusoria *J R Micr Soc*, VII, pp 35–40, 1 pl

—— (1887 *b*)—Some new Hypotrichous Infusoria from American Fresh-waters *Ann Mag Nat Hist*, (5) XX, pp 104–14, 1 pl

—— (1887 *c*)—Notices of new fresh-water Infusoria *Amer Mon Micr J*, VIII, pp 141–7

—— (1887 *d*)—Notices of new fresh water Infusoria *Proc Amer Phil Soc*, XXIV, pp 244–55

—— (1888)—A preliminary contribution toward a history of the fresh-water Infusoria of the United States *J Trenton Nat Hist Soc*, I, pp 71–319, 13 pls

—— (1891)—Notes of new Infusoria from the fresh waters of the United States *J R Micr Soc*, pp 697–704, 1 pl

—— (1893)—Notices of some undescribed Infusoria from the brackish waters of the Eastern United States *J R Micr Soc*, pp 298–302, pl v

STOLTE, H A (1924)—Morphologische und physiologische Untersuchungen an *Blepharisma undulans* Stein (Studien über den Formwechsel der Infusorien) *Arch Protistenk*, XLVIII, pp 245–301, pls x–xii, 53 text-figs

—— (1926)—Die Kultur von *Blepharisma undulans* Stein und seine Verwendung in zoologischen Kursen *Zool Anz*, LXV, pp 213–16

STRAND, E (1928)—Miscellanea nomenclatorica zoologica et palæontologica *Arch Naturgesch*, XCII, pp 30–69

STRANGHONER, E (1932)—Teilungsrate und Kernreorganisationsprozess bei *Paramæcium multimicronucleatum* *Arch Protistenk*, LXXVIII, pp 302–60, 54 figs

STRELKOW, A (1929)—Morphologische Studien über oligotriche Infusorien aus den Darme des Pferdes—I Äussere Morphologie und Skelett der Gattung *Cycloposthium* Bundle *Arch Protistenk*, LXVIII, pp 503–54, 2 pls, 29 text figs

—— (1931 *a*)—*Ibid*—II Cytologische Untersuchungen der Gattung *Cycloposthium* Bundle *Arch Protistenk*, LXXV, pp 191–220, pls xiv–xv, 12 text figs

—— (1931 *b*)—*Ibid*—III Korperbau von *Tripalmaria dogieli* Gassovsky *Arch Protistenk*, LXXV, pp 221–54, pl xvi, 19 text-figs

STUDITSKY, A N (1930 *a*)—Materialien zur Morphologie von *Dileptus gigas* Stein *Arch Protistenk*, LXX, pp 155–84, 1 pl, 34 text figs

—— (1930 *b*)—Eine neue Art der Gattung *Ptychostomum* Stein (*Lada* Vejdovsky), *Pt rossolimo* n sp Eine Systematische Studie *Zool Anz*, LXXXVII, pp 247–56, 4 figs

—— (1932)—Über die Morphologie, Cytologie und Systematik von *Ptychostomum chattoni* Rossolimo *Arch Protistenk* LXXVI, pp 188–216, 2 pls, 28 text figs

SUMMERS, F. M (1935)—The division and reorganisation of the macronuclei of *Aspidisca lynceus* Muller, *Diophrys appendiculata* Stein, *Stylonychia pustulata* Ehrbg *Arch Protistenk*, LXXXV, pp 173–208, pls v–x, 3 text figs

SWARCZEWSKY, B (1928 *a*)—Beobachtungen uber *Spirochona elegans* n sp *Arch Protistenk.*, LXI, pp 185–222, pls vii & viii, 1 text fig

—— (1928 *b*)—Zur kenntnis der Baikalprotistenfauna Die an den Baikalgammariden lebenden Infusorien—I *Dendrosomidæ* *Arch Protistenk*, LXI, pp 349–78, pls xiii & xiv

—— (1928 *c*)—Do.—II *Dendrocometidæ* *Arch Protistenk*, LXII, pp 41–79, pls ii & iii

—— (1928 *d*)—Do—III *Discophryidæ* *Arch Protistenk*, LXIII, pp 1–17, pl i

—— (1928 *e*)—Do—IV *Acinetidæ* *Arch Protistenk*, LXIII, pp 362–409, pls xiii–xv

—— (1928 *f*)—Do.—V *Spirochonina* *Arch Protistenk*, LXIV, pp 44–60, pl ii

—— (1929)—Do—VI *Stentorina* *Arch Protistenk*, LXV, pp 38–44, pl i

—— (1930)—Do—VII *Lagenophrys, Vaginicola,* und *Cothurnia* *Arch Protestink*, LXIX, pp 455–532, 3 pls, 5 text-figs

SWEZEY, W W (1932)—The transition of *Troglodytella abrassarti* and *Troglodytella abrassarti acuminata,* intestinal ciliates of the chimpanzee, from one type to the other *J Parasit*, XIX, pp 12–16, 8 figs

—— (1934)—Cytology of *Troglodytella abrassarti,* an intestinal ciliate of the chimpanzee *J Morph*, LVI, pp 621–34, 2 pls

—— (1935)—Cultivation of *Troglodytella abrassarti,* a parasitic ciliate of the chimpanzee *J Parasit*, XXI, pp 10–17

—— & ATCHLEY, F O (1935)—Comparative behaviour characteristics of free living and parasitic Ciliates *Trans Amer Micr Soc*, LIV, pp 98–102

TANABE, M, & KOMADA, K. (1932)—On the cultivation of *Balantidium coli* *Keijo J Med*, III, pp 385–92, 2 figs

TANNREUTHER, G W (1926)—Life history of *Prorodon teres* *Biol Bull Wood's Hole,* LI, pp 303–20, 34 figs

TAYLOR, C V (1920)—Demonstration of the function of the neuromotor apparatus in *Euplotes* by the method of micro-dissection *Univ Calif Publ Zool*, XIX, pp 403–70, pls xxix–xxxiii

—— (1929 *a*)—Experimental evidence of the function of the fibrillar system in certain protozoa *Amer Nat*, LXIII, pp 328–45, 4 figs

—— (1929 *b*)—Protoplasmic reorganisation in *Uronychia uncinata* n sp, during binary fission and regeneration *Physiol Zoöl*, I, pp 1–25, 15 figs

TCHANG-TSO-RUN, N (1931)—Contribution à l'étude de la division chez les Hypotriches *Ann Soc zool Belg*, LXII, pp 71–7, 3 pls

†THAPAR, G S, & CHAUDHURY, S S (1923)—The occurrence and significance of a third contractile vacuole in *Paramæcium caudatum* *J R Micr. Soc*, pp 64–8

THOMSON, J G, & ROBERTSON, A (1929)—Protozoology A manual for medical men London Pp xiii+376, 220 text figs, 4 col plates

THOMSON, R (1922)—Einiges uber die Morphologie von *Folliculina boltoni* *Arch Protistenk*, XLIV, pp 83–98, 17 figs

THON, K (1905)—Über den feineren Bau von *Didinium nasutum* O F M *Arch Protistenk*, V, pp 281-321, pls xii & xiii, 3 figs

TONNINGES, C (1914)—Die Trichocysten von *Frontonia leucas* (Ehrbg) und ihr chromidialer Ursprung Ein Beitrag zur Chromidialtheorie *Arch Protistenk*, XXXII, pp 298–378, pls xviii & xix, 23 text figs

TREILLARD, M, & LWOFF, A (1924)—Sur un Infusoire parasite de la cavité générale des larves de chironomes Sa sexualité *C R Acad Sci Paris*, CLXXVIII, pp 1761–4

TURNER, J P (1930)—Division and conjugation in *Euplotes patella* Ehrenberg, with special reference to the nuclear phenomena *Univ Calif Publ Zool*, XXXIII, pp 193–258, 12 pls

—— (1933)—The external fibrillar system of *Euplotes*, with notes on the neuromotor apparatus *Biol Bull Wood's Hole*, LXIV, pp 53–66, 4 pls, 3 text figs

UBISCH, M V (1913)—Ein Beitrag zur kenntnis der Gattung *Lageno phrys* *Arch Protistenk*, XXIX, pp 39–77, pl i

D'UDEKEM (1857)—Recherches sur le developpment des infusoires *Mém Acad R Belg Cl Sci*, XXX, pp 1–13

—— (1864)—Description des infusoires de la Belgique *Mém Acad R Belg Cl Sci*, XXXIV, pp 1–34, pls i–v

UNGER, W B (1931)—The Protozoan Sequence of Five Plant Infusions *Trans Amer Micr Soc*, L, pp 144–53

VEJDOWSKY, F (1882)—Thierische Organismen des Brunnenwassers von Prag

VISSCHER, J P (1927 *a*)—A neuromotor apparatus in the ciliate *Dileptus gigas* *J Morph*, XLIV, pp 373–81, 4 figs

—— (1927 *b*)—Conjugation in the ciliated protozoan, *Dileptus gigas*, with special reference to the nuclear phenomena *J Morph*, XLIV, pp 393-415, 26 figs

WAILES, G H (1925)—*Tintinnidæ* from the strait of Georgia, B C *Contr Canad Biol*, II, pp 531–9, 2 pls

WALKER, E L (1909)—Sporulation in the parasitic Ciliata *Arch Protistenk*, XVII, pp 297–306, pls xiv–xv

—— (1913)—Experimental Balantidiosis *Philipp J Sci*, VIII (B), pp 333–49, 7 pls

WANG, C C (1931)—On two new Ciliates (*Holophrya latericollaris* sp nov, and *Choanostoma pinigi* gen and sp nov) *Contr Biol Lab Sci Soc China*, VI, pp 105–11, 5 figs (Abstract in *J R Micr Soc*, p 433)

—— & NIE, D (1934)—Report on the rare and new species of fresh water Infusoria—Part I *Contr Biol Lab Sci Soc China*, X, pp 1–99, 75 figs

WARREN E (1932)—On a ciliate protozoon inhabiting the liver of a slug *Ann Natal Mus*, VII, pp 1–53, 1 pl, 7 text figs

WEILL R (1929)—Notes protistologiques indochinoises (Première série) 2 La presence d'un infusoire du genre *Isotricha* (*I caulleryi* n sp) chez un insecte (*Periplaneta americana* Forbes) et sa signification possible 3 Observations sur la morphologie nucléaire de *Opalina chattoni* n sp *Arch Zool exp gén* (Notes & Rev), LXIX, pp 12–37, 7 figs

WEISSE, J F (1847) —Verzeichniss von 155 in St Petersburg beobachteten Infusorien *Bull Acad Sci St Pétersb*, V, pp 39–47

—— (1863) —Verzeichniss aller von mir in einem 30 jährigen Zeitraum zu St Petersb beobachteten Infusorien, Bacillarien, Raderthiere *Bull Soc Nat Moscou*, pp 1–11

WENRICH, D H (1924 *a*) —A new Protozoan parasite, *Amphileptus branchiarum* n sp, on the gills of tadpoles *Trans Amer Micr Soc*, XLIII, pp 191–9, pls ix & x

—— (1924 *b*) —Protozoa on the skin and gills of tadpoles *Trans. Amer Micr Soc*, XLIII, pp 200–2

—— (1926) —The structure and division of *Paramecium trichium* Stokes *J Morph*, XLIII, pp 81–102, 2 pls, 1 text-fig

—— (1928 *a*) —*Paramecium woodruffi* n sp *Trans Amer Micr Soc*, XLVII, pp 256–61, pls xxxiii & xxxiv

—— (1928 *b*) —Eight well defined species of *Paramecium* (Protozoa, Ciliata) *Trans Amer Micr Soc*, XLVII, pp 275–82, pls xxxvi & xxxvii

—— (1929 *a*) —The structure and behaviour of *Actinobolus vorax* n sp (Protozoa, Ciliata) *Biol Bull Wood's Hole*, LVI, pp 390–401, 5 figs

—— (1929 *b*) —Observations on some freshwater ciliates (Protozoa) —I *Teuthophrys triscula* Chatton & de Beauchamp and *Stokesia vernalis*, n g, n sp *Trans Amer Micr Soc*, XLVIII, pp 221–41, 2 pls

—— (1929 *c*) —Do —II *Paradileptus*, n gen *Trans Amer Micr Soc*, XLVIII, pp 352–65, 2 pls

—— (1935) —Host parasite relations between parasitic Protozoa and their hosts *Proc Amer Phil Soc*, LXXV, pp 605–50, pls i–v

—— & WANG, C C (1928) —The occurrence of conjugation in *Paramecium calkinsi* *Science*, LXVII, pp 270–1

WENYON, C M (1926) —Protozoology a manual for medical men, veterinarians and zoologists London 2 vols, pp xvi + 1563, 565 text figs, 20 col plates

WERTHEIM, P (1932) —Zur Kenntnis der Ophryoscoleciden *Zool Anz*, XCVIII, pp 237–48, 4 figs

—— (1933) —Ein Beitrag zu den Untersuchungen uber die Ophryoscoleciden fauna aus dem Magen von *Capra ibex* L *Zool Anz*, CIV, pp 15–25, 6 figs

—— (1934 *a*) —Über die Infusorienfauna im Magen von *Bos taurus* L. *Ann Mus zool polon*, X, pp 251–66

—— (1934 *b*) —Neue Entodinien aus dem Rindermagen *Zool Anz*, CVIII, pp 45–7, 2 figs

—— (1935) —A new Ciliate, *Entodinium bovis* n sp, from the stomach of *Bos taurus* L, with the revision of *Entodinium exiguum*, *E nanellum*, *E simplex*, *E dubardi dubardi* and *E parvum*. *Parasitology*, XXVII, pp 226–30, 6 figs

WETZEL, A (1925) —Vergleichen cytologische Untersuchungen an Ciliaten *Arch Protistenk*, LI, pp 209–304, 48 figs

—— (1927) —Über zwei noch unbekannte holotricher Ciliaten *Frontoniella complanata* nov gen, nov spec und *Spathidium caudatum* n sp *Arch Protistenk*, LX, pp 130–41, 7 figs

WEYER, G (1930)—Untersuchungen über die Morphologie und Physiologie des Fromwechsels der *Gastrostyla steinii* Engelmann *Arch Protistenk*, LXXI, pp 139–228, 83 figs

WICHTERMAN, R (1933)—A new species of *Nyctotherus* (Protozoa, Ciliata) from a Chinese frog *J Parasit*, XX, p 122

—— (1934)—A new protozoan parasite, *Nyctotherus cheni* n sp (Ciliata), from Chinese frogs *Parasitology*, XXVI, pp 163–6, 2 figs

WOODCOCK, H M, & LODGE, O (1921)—Parasitic protozoa In British Antarctic ('Terra Nova') Expedition, 1910, Nat Hist Rep, Zoology, VI, i, pp 1–24, 3 pls

WOODRUFF, L L (1911 *a*)—Evidence on the adaptation of *Paramœcia* to different environments *Biol Bull Wood's Hole*, XXII, pp 60–5

—— (1911 *b*)—*Paramœcium aurelia* and *Paramœcium caudatum* *J Morph*, XXII, pp 223–37

—— (1914 *a*)—A five-year pedigreed race of *Paramœcium* without conjugation *Proc Soc Exp Biol, N Y*, IX, pp 121–3

—— (1914 *b*)—So called conjugating and non-conjugating races of *Paramœcium* *J Exp Zool*, XVI, pp 237–40

—— (1914 *c*)—A normal periodic re organisation process without cell-fusion in *Paramœcium* *J Exp Zool*, XVII, pp 425–517, 4 pls

—— (1917 *a*)—Rhythms and endomixis in various races of *Paramœcium aurelia* *Biol Bull Wood's Hole*, XXXIII, pp 51–6

—— (1917 *b*)—The influence of general environmental conditions on the periodicity of endomixis in *Paramœcium aurelia* *Biol Bull Wood's Hole*, XXXIII, pp 437–62

—— (1921 *a*)—The structure life history and intra generic relationships of *Paramœcium calkinsi* sp nov *Biol Bull Wood's Hole*, XLI, pp 171–80

—— (1921 *b*)—The present status of the long continued pedigree culture of *Paramœcium aurelia* at Yale University *Proc Nat Acad Sci Wash*, VII, pp 41–4

—— (1921 *c*)—Micronucleate and amicronucleate races of Infusoria *J Exp Zool*, XXXIV, pp 329–37

—— (1925)—The physiological significance of conjugation and endomixis in the Infusoria. *Amer Nat*, LIX, pp 225–49

—— (1926)—Eleven thousand generations of *Paramecium* *Quart Rev Biol*, I, pp 436–8

—— (1932)—*Paramecium aurelia* in pedigree culture for twenty-five years *Trans Amer Micr Soc*, LI, pp 196–8

—— & SPENCER, H (1922)—Studies on *Spathidium spathula*—I The structure and behaviour of *Spathidium*, with special reference to the capture and ingestion of its prey *J Exp Zool*, XXXV, pp 189–204, 1 pl, 8 text-figs

—— (1924)—Studies on *Spathidium spathula*—II. The significance of conjugation *J Exp Zool*, XXXIX, pp 133–96

WRIGHT, W R (1930)—Occurrence of *Cepedea* in Frogs *Nature*, CXXV, p 52

WRZESNIOWSKY, A O (1861)—Observations sur quelques Infusoires *Ann Sci nat Paris*, (4) XVI, p 327, pls 8–9

—— (1869)—Ein Beitrag zur Anatomie der Infusorien *Arch micr Anat*, V, pp 25–49, pls iii–iv

WRZEŚNIOWSKY, A O (1870)—Beobachtungen über Infusorien aus der Umgebung von Warschau *Z wiss Zool*, XX, pp 467–511.

YAGIU, R (1933)—Studies on the Ciliates from the intestine of *Anthocidaris crassispina* (A Agassiz)—I *Cyclidium ozakii* sp. nov and *Strobilidium rapulum* sp nov *J. Sci Hiroshima Univ.* (Ser B, Div 1), II, pp 211–22, 2 pls, 2 text-figs

YOCOM, H B (1918)—The neuromotor apparatus of *Euplotes patella*. *Univ Calif Publ Zool*, XVIII, pp 337–96, pls xiv–xvi

YOUNG, D B (1922)—A contribution to the morphology and physiology of the genus *Uronychia* *J Exp Zool*, XXXVI, pp 353–90, 3 pls, 3 text figs

—— (1926)—Nuclear regeneration in *Stylonychia mytilus* *Biol. Bull Wood's Hole*, LI, pp 163–5

YOUNG, R T (1917)—Experimental induction of endomixis in *Paramæcium aurelia* *J Exp Zool*, XXIV, pp 35–53

—— (1918)—The relation of rhythms and endomixis, their periodicity and synchronism in *Paramæcium aurelia* *Biol Bull Wood's Hole*, XXXV, pp 38–47

ZACHARIAS, O (1892)—Ueber eine *Ichthyophthirius* Art aus der Aquarien der Biologischen Station zu Plon Festschr zum 70 Geburtstag R Leuckarts, pp 289–92, 1 pl

—— (1893)—Ein infusorieller Hautparasit bei Süsswasserfischen *Biol Zbl*, XIII, pp 23–5 (*J R. Micr Soc*, pp 198 & 340)

ZELLER, E (1877)—Untersuchungen über die Fortpflanzung und Entwicklung der in unseren Batrachiern schmarotzenden Opalinen *Z wiss Zool*, XXIX, pp 352–80

ZICK, K (1928)—*Urceolaria Korschelti* n sp eine neue marine Urceolarine, nebst einem Uberblick uber die Urceolarinen *Z wiss. Zool* CXXXII, pp 355–403, pls vi–viii, 14 text figs

ZINGER, J A (1929)—Beiträge zur Morphologie und Cytologie der Süsswasserinfusorien *Arch russes Protist*, VIII, pp 51–90, 1 pl, 26 text figs

—— NARBUTT, K J, & ZINGHER, W A (1932)—Biometrische Untersuchungen an Infusorien—II Über die Mittelgrosse und Variabilität von *Paramæcium caudatum* und *Stylonychia pustulata* *Arch Protistenk*, LXXVII, pp 73–90, 2 pls, 8 figs

ZWEIBAUM, J (1912)—La conjugation et la differenciation sexuelle chez les Infusoires (Enriques u Zweibaum)—V Les conditions necessaries et suffisantes pour la conjugation du *Paramæcium caudatum* *Arch Protistenk*, XXVI, pp 275–393, 3 figs

ALPHABETICAL INDEX.

Names of Genera and larger groups begin with a capital letter
All names printed in italics occur as synonyms on the pages referred to

PLATE I

Fig 1 *Entodinium acutonucleatum* Kof & MacL

2 ,, *longinucleatum* Dogiel

3 ,, *laterospinum* Kof & MacL

4 ,, *indicum* Kof & MacL

5 ,, *tricostatum* Kof & MacL

[From Kofoid & MacLennan's Ciliates from *Bos indicus* Linn , 1930]

OPHORA

PLATE I

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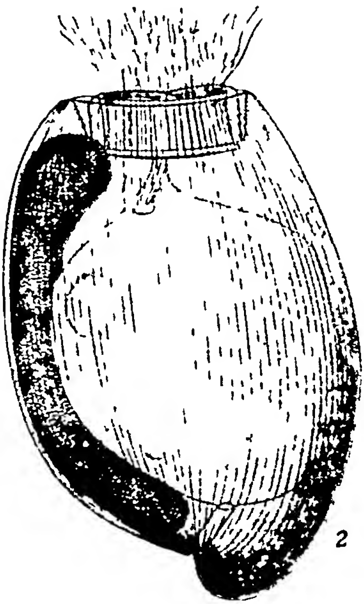

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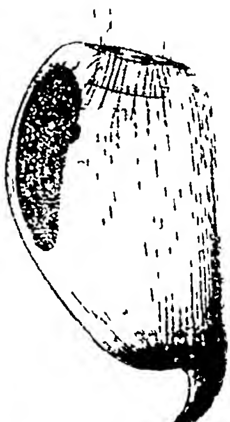

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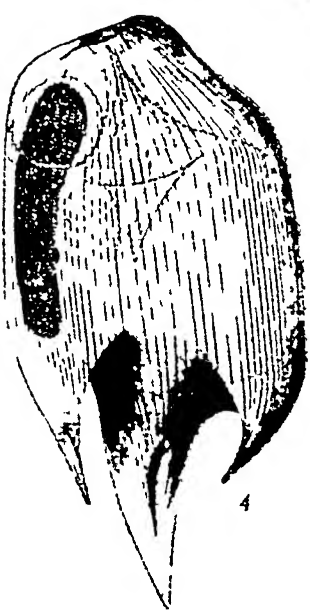

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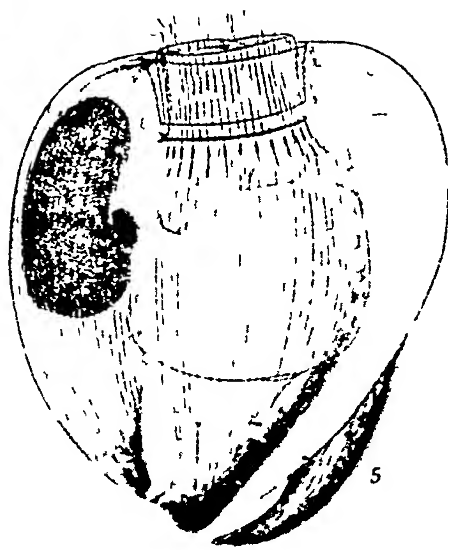

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PLATE II

Fig 6 *Entodinium rostratum* Fiorentini

7. ,, *rhomboideum* Kof & MacL

8 ,, *nanellum* Dogiel

9 ,, *pisciculum* Kof & MacL

10 ,, *bimastus* Dogiel.

[From Kofoid & MacLennan's Ciliates from *Bos indicus* Linn , 1930]

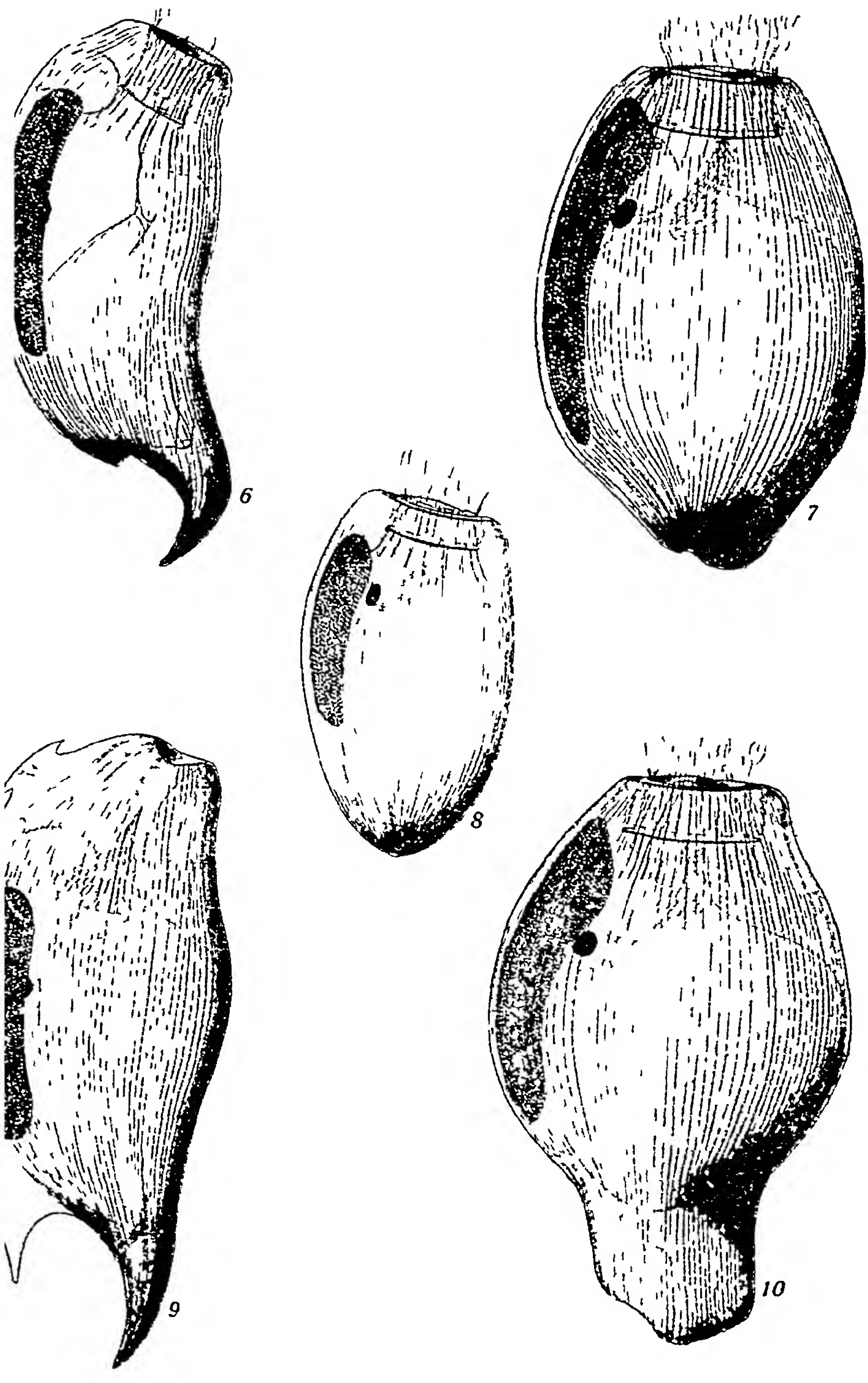
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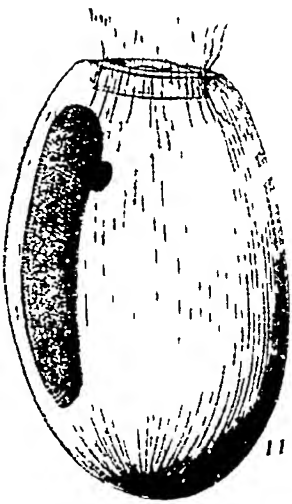
PLATE III

Fig	11	*Entodinium*	*ovoideum* Kof & MacL
	12	,,	*aculeatum* Kof & MacL
	13	,,	*bifidum* (Dogiel)
	14	,,	*biconcavum* Kof & MacL
	15	,,	*acutum* Kof & MacL

[From Kofoid & MacLennan's Ciliates from *Bos indicus* Linn , 1930]

PLATE III



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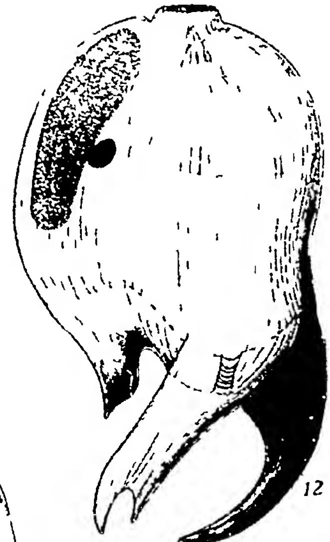

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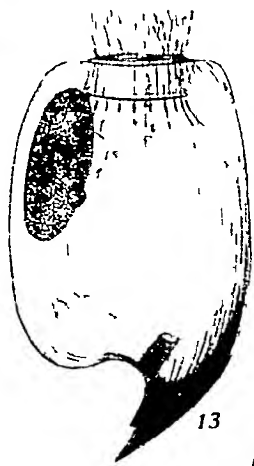

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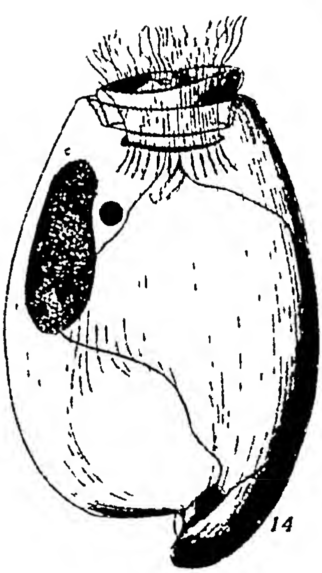

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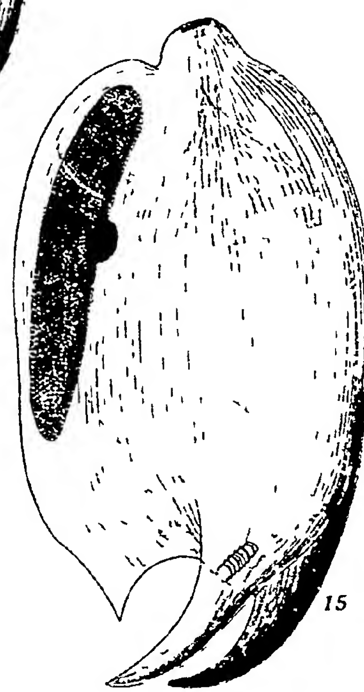

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PLATE IV

Fig 16 *Entodinium laterale* Kof & MacL

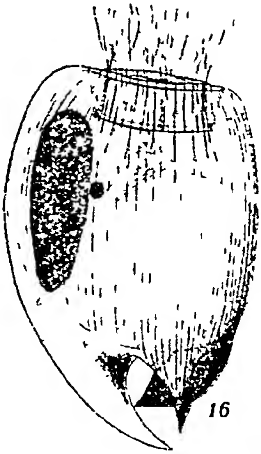
17 „ *ellipsoideum* Kof & MacL

18 „ *brevispinum* Kof & MacL

19 „ *rectangulatum* Kof & MacL

20 „ *gibberosum* Kof & MacL

[From Kofoid & MacLennan's Ciliates from *Bos indicus* Linn , 1930]



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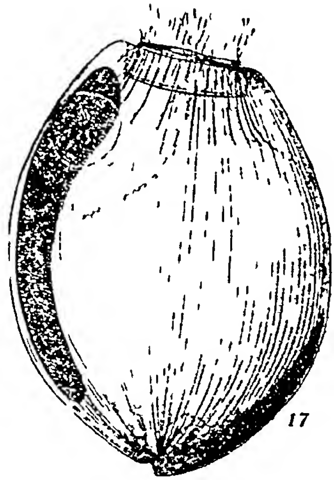

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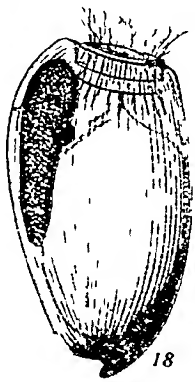

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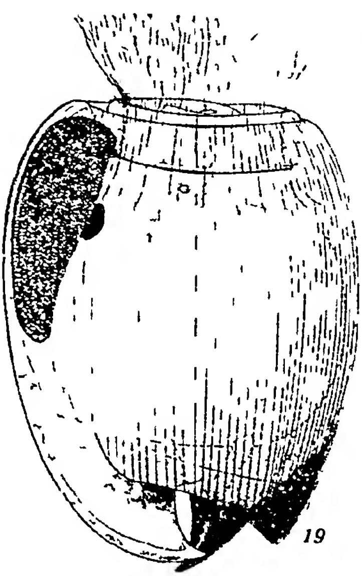

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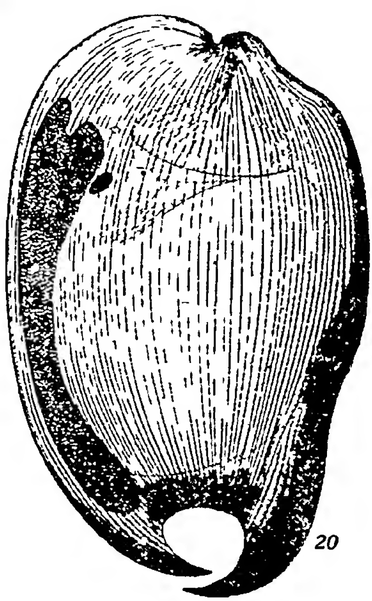

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PLATE V

Fig 1 *Diplodinium psittaceum* Dogiel
2 „ *dentatum* Schuberg
3 *Eodinium lobatum* Kof & MacL
4 „ *rectangulatum* Kof & MacL
5 *Diplodinium ceylonicum* Kof & Christ
6 „ *flabellum* Kof & MacL

[From Kofoid & MacLennan's Ciliates from *Bos indicus* Linn , 1932]

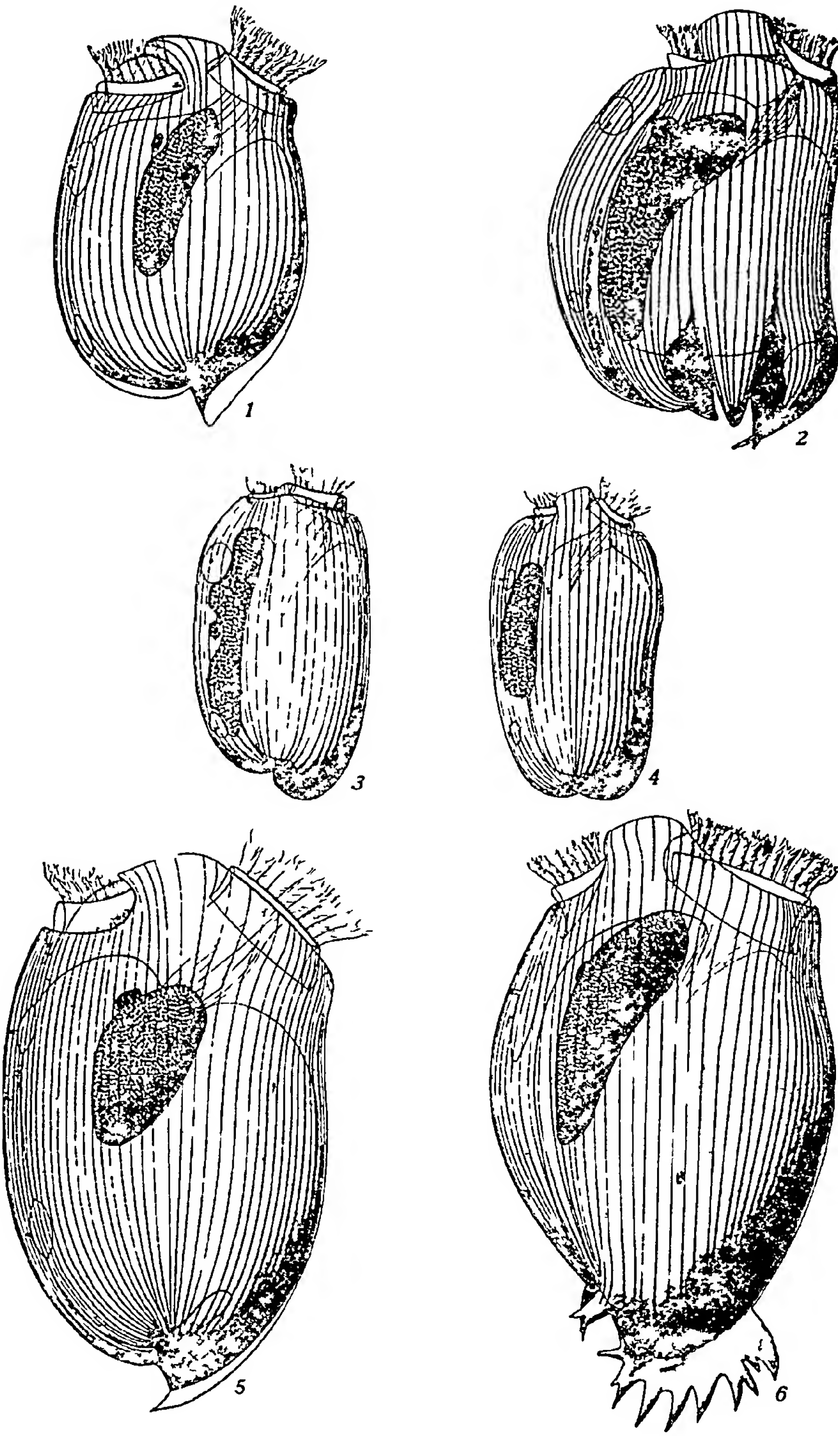
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PLATE VI

Fig 7 *Eremoplastron rostratum* (Fiorentini)

8 ,, *brevispinum* Kof & MacL

9 ,, *magnodentatum* Kof & MacL

10 ,, *bovis* (Dogiel)

11 *rotundatum* Kof & MacL

12 *Eudiplodinium maggii* (Fiorentini)

[From Kofoid & MacLennan's Ciliates from *Bos indicus* Linn , 1932]

PLATE VII

Fig 13 *Elytroplastron bubali* (Dogiel) Left lateral view

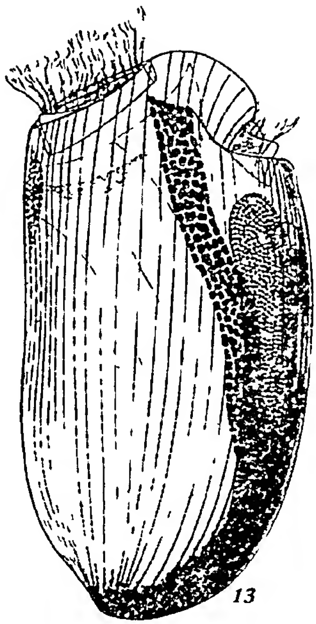
14 ,, ,, ,, Right lateral view

15 *Ostracodinium clipeolum* Kof & MacL

16 *Metadinium medium* Awerinzew & Mutafowa

[From Kofoid & MacLennan's Ciliates
from *Bos indicus* Linn , 1932]

PLATE VII



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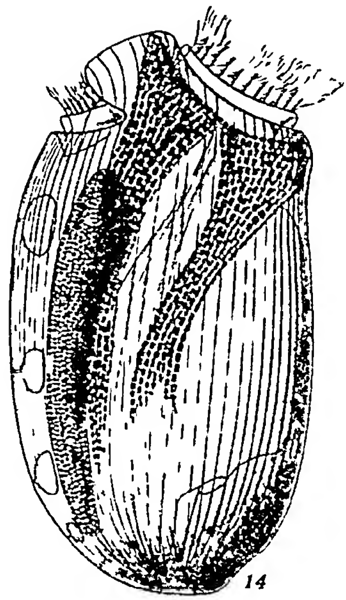

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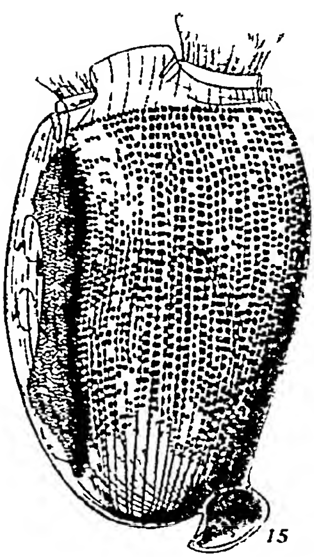

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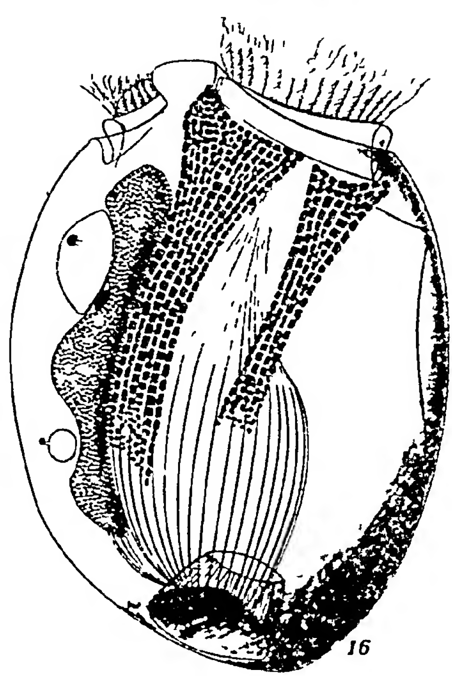

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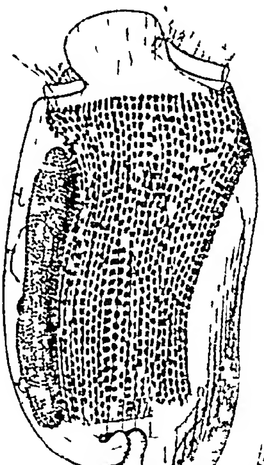
PLATE VIII

Fig 17	*Ostracodinium*	*mammosum* (Railliet)
18	,,	*gracile* (Dogiel)
19	,,	*quadrivesiculatum* Kof & MacL
20	,,	*rugoloricatum* Kof & MacL
21	,,	*venustum* Kof & MacL
22	,,	*trivesiculatum* Kof & MacL

[From Kofoid & MacLennan's Ciliates from *Bos indicus* Linn , 1932]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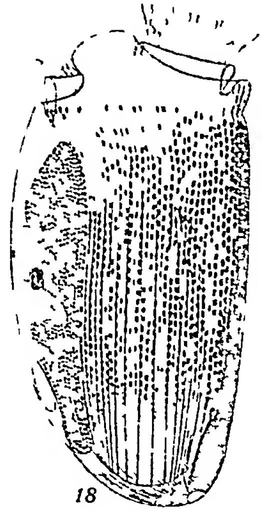
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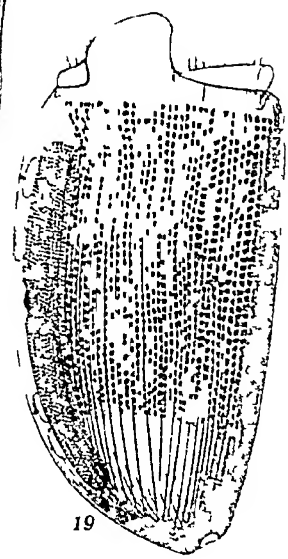
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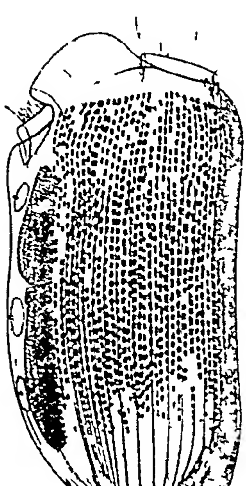
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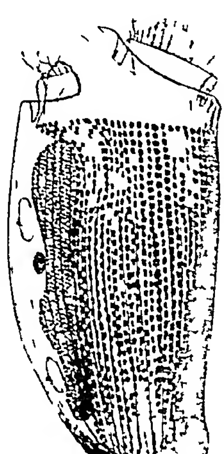
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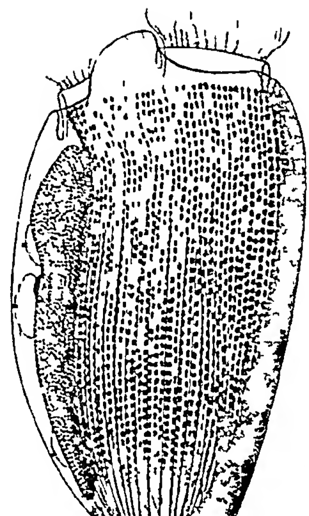
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PLATE IX

Fig 1 *Epidinium caudatum* (Fiorentini)

2 ,, *tricaudatum* (Sharp)

3 ,, *quadricaudatum* (Sharp)

4 ,, *bicaudatum* (Sharp)

5 ,, *eberleini* (da Cunha)

6 *Ophryoscolex spinosus* Kof & MacL

7 *Epidinium cattanei* (Fiorentini)

[From Kofoid & MacLennan's Ciliates from *Bos indicus* Linn , 1933]

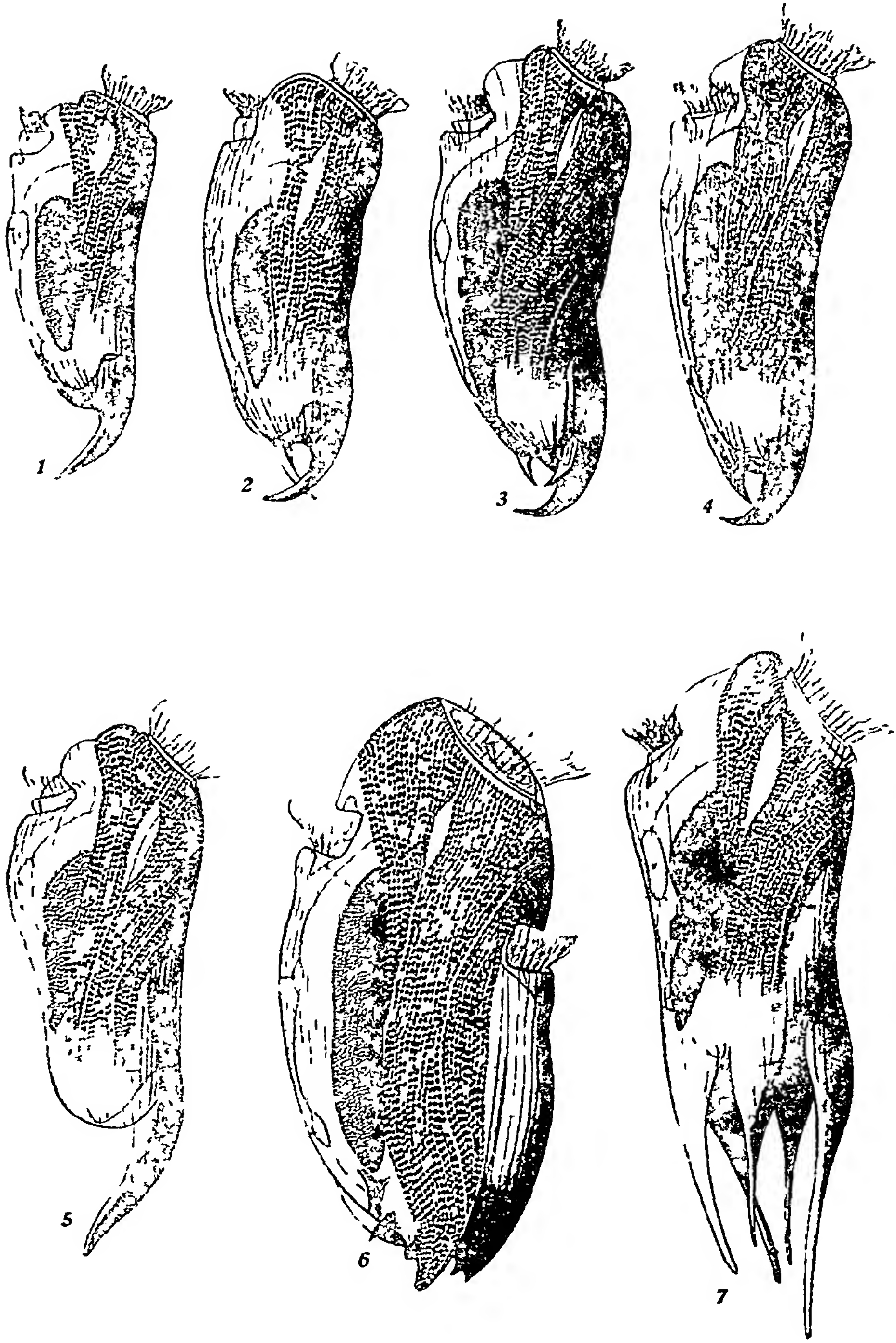
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PLATE X.

Fig 1. *Entodinium contractum* Kof & Christ

2 ,, *curtum* Kof & Christ

3 *Eodinium bilobosum* (Dogiel).

4 *Diplodinium minor* (Dogiel)

5 ,, *diacanthum* (Dogiel)

6 ,, *triacanthum* (Dogiel).

7. ,, *tetracanthum* (Dogiel).

8 ,, *pentacanthum* (Dogiel).

9 ,, *anisacanthum* da Cunha

[From Kofoid & Christenson's Ciliates from *Bos gaurus* H Smith, 1934.]

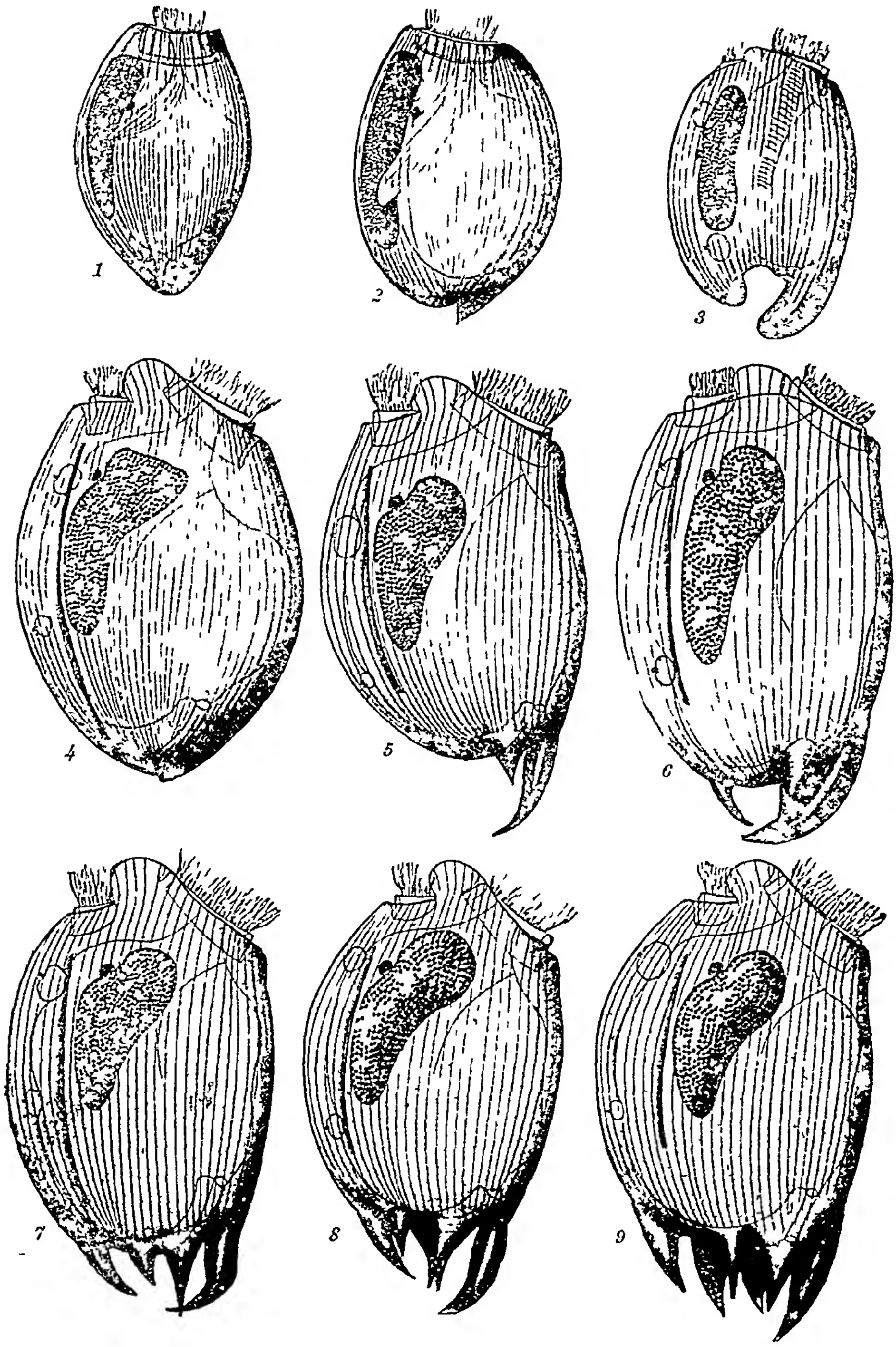
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PLATE XI.

Fig 10 *Epidinium parvicaudatum* (Awerinzew & Mutafowa)

11 *Metadinium rotundatum* Kof & Christ

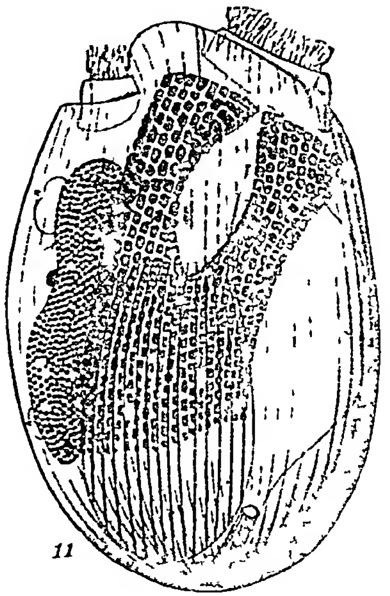
12 *Eremoplastron rostratum* (Fiorentini).

13 *Eudiplodinium maggi* (Fiorentini)

14 *Ostracodinium gauri* Kof & MacL

15 „ *mysorei* Kof & MacL

[From Kofoid & Christenson's Ciliates from *Bos gaurus* H Smith, 1934]



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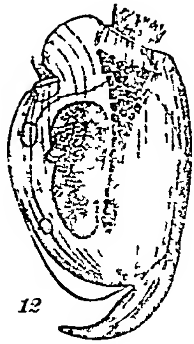

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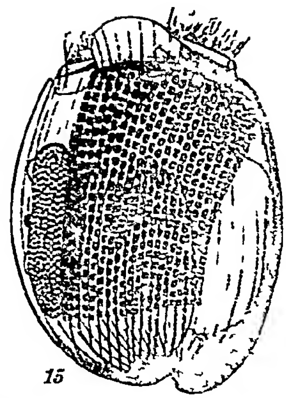

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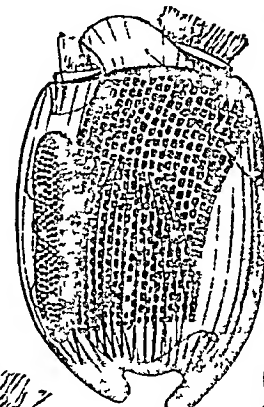

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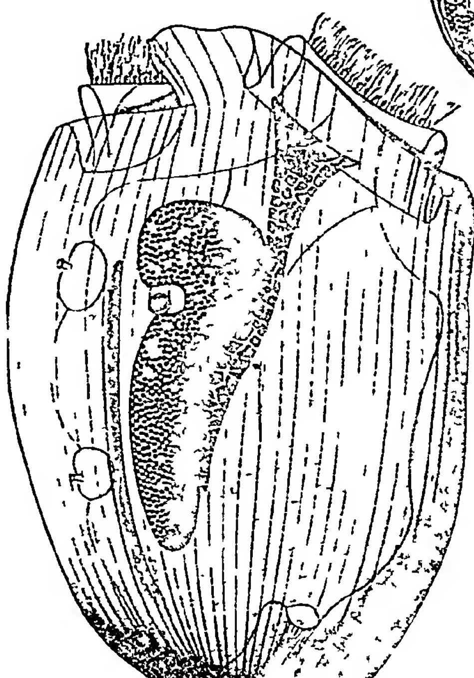

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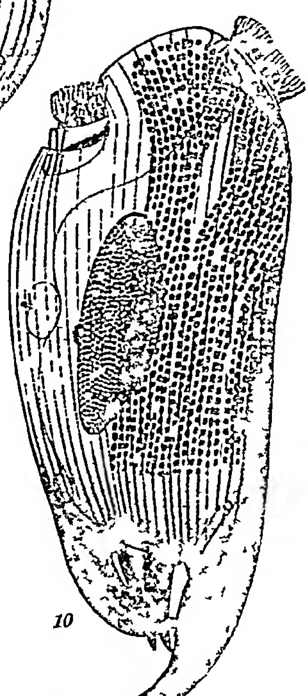

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